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19. Current and future high performance aircraft operate in an envelope which requires both high altitude and acceleration protection for their aircrew. Such protection includes both positive pressure breathing (PPB) and an anti-G suit. These factors have been incorporated into a variety of different aircrew clothing ensemble concepts. As part of an ongoing US Navy evaluation of these integrated life support ensembles, 7 subjects (6 male) were exposed to acceleration stress in the Naval Air Warfare Center Aircraft Division Warminster human centrifuge while wearing the Combined Advanced Technology Enhanced Design G Ensemble (COMBAT EDGE - CE) or the Tactical Life Support System (TLSS). The following report describes how cardiac function, as measured using impedance cardiography, was effected under +Gz-stress will subjects wore these ensembles. It was found that relaxed rapid onset +Gz-tolerance (without anti-G straining maneuvers) was about 1.5 G higher when the subjects wore TLSS as compared to CE. Stroke (SI) and (CI) indices both decreased and heart rate rose as +Gz-stress was increased regardless of the outfit worn. While the absolute value of these induces were somewhat higher when CE was worn, the relative change in SI and CI ( $\Delta SI$ ,  $\Delta CI$ ) with respect to pre-stress values was smaller with the TLSS ensemble. For both

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garments,  $\Delta SI$  and  $\Delta CI$  was greatest at +6 Gz (PBG = 24 mmHg). However, TLSS  $\Delta SI$  and  $\Delta CI$  were markedly reduced with PBG levels  $\geq 30$  mmHg (+6.5 Gz). No statistically significant differences between TLSS  $\Delta SI$  and  $\Delta CI$  at +4 or +7 Gz (0 and 36 mmHg, respectively) were found. At all +Gz exposures, the change in cardiac contractility was fairly consistent ( $\pm 10\%$  relative to pre-stress levels) for subjects wearing the TLSS while it was two to three times greater when they wore the CE. Also, at higher PPB levels, cardiac contractility was greater when TLSS was worn as compared to the CE. It is postulated that for this group of subjects, the TLSS garment enabled individuals to maintain a more consistent stroke volume and level of cardiac contractility over a large range of stress levels than the CE ensemble. These factors, in combination with an increased heart rate and increased lower limb coverage (which theoretically causes a higher peripheral arterial and atrial pressure), may have led to the increased +Gz-tolerance levels obtained when subjects wore the TLSS ensemble.

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## INTRODUCTION

The US Navy has been investigating the use of positive pressure breathing (PPB) and extended coverage flight suits as a means for enhancing G-tolerance, reducing the incidence of G-induced loss of consciousness and protection during emergency descent from altitudes up to 60,000 feet in high performance aircraft. In this study, 7 subjects (6 male) participated from 9/16/91 to 9/20/91 wearing COMBined Advanced Technology Enhanced Design G Ensemble (COMBAT EDGE - CE) and Tactical Life Support System (TLSS) ensembles during Naval Air Warfare Center Aircraft Division Warminster (NAWC) human centrifuge exposures. CE differs from TLSS in that its lower garment is the standard five bladder anti-G suit which covers 40% less surface area than TLSS. The following report describes how cardiac function was effected under +Gz-stress while subjects wore these ensembles.

## METHODS

### I. Measurements and calculations:

1. Instrumentation included electrocardiography (ECG), impedance cardiography (ICG), peripheral blood velocity (infrared plethysmograph placed on the forehead), blood pressure, mask, regulator outlet and anti-G suit pressures and phonocardiography.

2. Subjects were exposed to rapid onset +Gz exposures, ROR (2 sec onset and offset rates), consisting of 30 sec plateaus. Exposures began at +3 Gz and were incremented by +1 Gz until peripheral light loss (PLL) reached 45°, at which point the +Gz level was increased by 0.5 until light loss reached 60°. Subjects were also exposed to gradual onset runs, GOR (rate = 1 G/10 sec), which continued until PLL reached 60°, at which point subjects performed an anti-G straining maneuver (AGSM) until 60° PLL was reached a second time. Many of the subjects either did not perform the straining portion of this profile or were not exposed to GOR's at all due to the occurrence of arm pain.

3. Data were recorded using a TEAC FM instrumentation recorder, which were subsequently digitized using Global Lab<sup>7</sup>. Measurements of +Gz level,  $Z_0$ ,  $dZ/dt_{max}$ , left ventricular ejection time (LVET, the period between the point in which the rise in  $dZ/dt$  crosses the  $dZ/dt$  zero level to the subsequent minimum point following  $dZ/dt_{max}$ ), pulse wave delay (PWD: time from ECG R wave peak to  $dZ/dt$  peak) and heart rate (HR) were recorded during the 6-10 sec period prior to +Gz-onset (pre-run), at 10, 20 and 30 sec at +Gz plateau during ROR's, and 20 - 30 sec after +Gz-offset (recovery) using Global Lab. GOR measures were taken at each incremental G level, i.e. 2, 3, 4, ... until subjects experienced 60° PLL or reached +10 Gz. All calculated values represented averages taken from 4 to 6 waveforms to reduce noise and artifact corruption.

4. Stroke volume (SV), cardiac output (CO), heather index (HI, cardiac contractility), stroke index (SI), body surface area (BSA), cardiac index (CI), as well as normalized parameters (relative to pre-run values for each exposure - indicated by a  $\Delta$  prefix)  $\Delta SI$ ,  $\Delta CI$ ,  $\Delta HI$ ,  $\Delta PWD$  and  $\Delta HR$  were calculated for all relaxed runs.

5. The following formulae were used:

$$\begin{aligned} SV \text{ (ml/beat)} &= (\rho * L^2 * LVET * dZ/dt_{max}) / Z_0^2 \\ CO \text{ (liters/min)} &= (SV * HR) / 1000 \end{aligned}$$

$$\begin{aligned}
 HI (\Omega) &= dZ/dt_{\max} / PWD \\
 BSA (m^2) &= 0.202 \text{ m/kg} * \text{height (m)}^{0.725} * \text{weight (kg)}^{0.425} \\
 SI (\text{ml/beat}/m^2) &= SV / BSA \\
 CI (\text{L/min}/m^2) &= CO / BSA
 \end{aligned}$$

with  $Z_0$  in  $\Omega$ ,  $dZ/dt_{\max}$  in  $\Omega/\text{sec}$  (measured from  $dZ/dt$  zero to peak),  $L$  in cm (distance between the two inner ICG electrodes),  $\rho = 150 \Omega \text{ cm}$ , LVET and PWD in sec and HR in beats/min.

6. Plots were created for each subject for each insertion for all of the cardiac parameters listed above. Graphs used to compare individual subject responses versus group means were also plotted.

## II. Measurement problems:

1. From the TEAC FM tapes,  $Z_0$  was measured for calibration values and during pre-run periods. For 9/17-21 data, the digitized values for  $Z_0$  had no dc offset (this offset is due to the impedance of the muscle and tissues of the torso) and were inverted with respect to oscilloscope values, i.e. negative voltages were recorded. However, the Global Lab trends (i.e. slopes) were correct while the TEAC trends were not. It was assumed that the data acquisition setup program was incorrectly configured to remove the offset and invert  $Z_0$ . 9/16/91 data were consistently recorded on the TEAC FM tape and reproduced using Global Lab. However, the gain settings were very low.  $dZ/dt$  calibrations were about half of standard and  $Z_0$  were about a tenth of standard. To use the  $Z_0$  data,  $Z_0$  values were first adjusted to remove any negative offset and then scaled according to the standard calibration range of  $10 \Omega/\text{volt}$ .  $Z_0$  was then processed with a 6<sup>th</sup> order digital low-pass Butterworth filter with a cut-off frequency of 0.5 Hz to remove respiratory artifacts.

2.  $dZ/dt$  maximum and zero-crossing values during calibrations were measured using an oscilloscope and with Global Lab. These values were consistent with each other.  $dZ/dt$  was then modified with a 4<sup>th</sup> order digital Butterworth high-pass filter using a cut-off frequency of 2 Hz to remove baseline shifts.

3. The distance between the two inner electrodes ( $L$ ) was not taken on a few subjects thereby rendering those data runs unusable for impedance cardiographic analysis.

4. Some TLSS data was too noisy (spikes) and could not be analyzed. All of Subject S7 data was discarded due to excess noise.

5.  $\rho$  (blood resistivity) was held constant since hematocrits were not taken.

6. When ECG quality was poor, HR was estimated using the period between  $dZ/dt$  peaks.

## III. Statistical Analysis (Using the Number Cruncher Statistical System (NCSS) <sup>4</sup>):

Two way unpaired t-tests (for unequal variances, NCSS provides an approximate t-test) and one and two-way analysis of variance (ANOVA) (when variances between classes was equal) were performed testing for suit and/or +Gz-level differences on the following data sets:

- a. ROR +Gz-tolerance runs
- b. ROR 60° peripheral light loss runs
- c. ROR's compared using common +Gz-levels
- d. ROR's comparing differences between +4 Gz and higher +Gz-levels
- e. GOR's compared for suit effects only
- f. In all cases, only relaxed (no AGSM) data was used

Post hoc Fisher's Least Significant Difference Comparison (LSD) tests were performed following the ANOVA's to determine the interaction between tested factors, where  $\alpha$  was set at 0.05.

In addition, nonparametric versions of the two sample t-test, the Mann-Whitney Two Sample Test, and the one-way ANOVA, the Kruskal-Wallis test, were also used.

## DATA

Subject physical characteristics are given in Table 1. During these tests, subjects reported several incidents of pain in the extremities which at times was so bothersome that some insertions were prematurely terminated. In fact, for some subjects, GOR's did not include AGSM or were even run at all due to subject discomfort. A description of the distribution of pain locations is given in Table 2.

Subject ROR +Gz-tolerances are summarized in Tables 3 and 4. Tables 5 and 6 contain GOR +Gz-tolerances.

Figures 1 to 18 show how  $\Delta CI$ ,  $\Delta SI$ ,  $\Delta HI$ ,  $\Delta HR$  and  $\Delta PWD$  differed between CE and TLSS during +Gz-tolerance runs for subjects S1, S2, S3 and S6. Figures 19 to 28 present mean responses for CE and TLSS based on common +Gz levels. Figures 29 to 38 display mean TLSS values. Appendix A contains all calculated cardiac indices for each subject.

Subject	Sex	Height (m)	Weight (kg)	BSA (m <sup>2</sup> )
S1	F	1.65	56.70	1.62
S2	M	1.92	81.65	1.64
S3	M	1.80	71.21	1.90
S4	M	1.78	70.99	1.88
S5	M	1.73	74.84	1.88
S6	M	1.75	74.84	1.90
S7	M	1.65	63.50	1.69
MEANS +/- 1 sd:		1.75 +/- 0.09	70.53 +/- 8.19	1.79 +/- 0.13

TABLE 1. Physical characteristics on the subject pool.

Subject	Date	Suit	Body Part	Run type
S1	9/17	TLSS	arm	post GOR/AGSM
S1	9/19	TLSS	calf	ROR: +5 Gz
S5	9/17	TLSS	forearm	ROR: +3 to 6 Gz
S5	9/17	TLSS	forearm, calf	GOR
S6	9/18	TLSS	arm	ROR/AGSM: +8 Gz
S7	9/20	TLSS	arm	ROR: +3 to 8 Gz
S7	9/20	TLSS	arm	ROR/AGSM: +9 Gz
S2	9/19	CE	arm	ROR/AGSM: +7 Gz
S5	9/16	CE	arm	GOR
S5	9/16	CE	arm	ROR: +3 to 4 Gz
S5	9/19	CE	arm	ROR: +8 Gz
S6	9/17	CE	forearm	GOR/AGSM
S6	9/19	CE	abdomen	ROR: +7 Gz
S6	9/19	CE	wrist	ROR/AGSM: +8 Gz

TABLE 2. Incidents and locations of pain reported during insertions.

Subject	Date	Relaxed		AGSM		Analyzed?
		+Gz-Tolerance	Light Loss	+Gz- Tolerance	Light Loss	
S1	9/16	6.5	0	8.5	30-75	Y
S1	9/18	5.0	59	6.5	59	Y
S2	9/17	5.5	75	7.0	50	Y
S2	9/19	4.5	0	7.0 (Arm pain)		Y
S3	9/16	4.5	45	8.0	75	Y
S3	9/18	4.0	60-75	7.5	0	Y
S4	9/17	6.5	59	9.0 (MO: PVCs)		N 1
S5	9/16	5.0	0	8.5	75	N 1
S5	9/19	7.0	0	NOT RUN		Y
S6	9/17	4.5	65 transient	8.0	45	Y
S6	9/19	6.0	50	8.0 (wrist pain)	0	Y
S7	9/17	6.0	60	NOT RUN		Y 2
S7	9/19	4.5	45	7.0	45	Y 2
MEANS +/- 1 sd:		5.35 +/- 0.97	(N = 13)	7.63 +/- 0.74	(N = 8)	

TABLE 3. +Gz-tolerance during rapid onset runs while wearing Combat Edge. Key: Y: data was analyzed; N: not analyzed due to: 1 - L not recorded; 2 - data analyzed but too noisy to include in statistical analysis; MO: medical officer; PVC: premature ventricular contraction.

Subject	Date	Relaxed		AGSM		Analyzed?
		+Gz-Tolerance	PLL	+Gz-Tolerance	PLL	
S1	9/17	8.0	0	> 10.0		Y
S1	9/19	(Arm pain-5.0)	0	NOT RUN		N 4
S2	9/16	6.5	60	9.0	30	Y
S2	9/18	7.5	30	9.0	0	Y
S3	9/17	6.5	59	8.0	0	Y
S3	9/19	5.5	25	8.0	60 - 0	Y
S4	9/16	5.5	60	8.5	0	Y
S4	9/18	5.5	55	10.0+ Inadvertent EOR		Y
S4	9/19	6.5	59	> 10.0		Y
S5	9/17	(Arm pain-6.0)	0	NOT RUN		N 2
S5	9/19	6.0	75 - 0	(Subj Terminate-7.5)		Y
S6	9/16	4.0	0	7.5	0	N 1
S6	9/18	6.5	50	8.0 (arm pain)	0	Y
S7	9/18	7.0	50	(Subj Terminate-8.5)	0	N 3
S7	9/20	7.5	59	(Subj Terminate-9.0)	30	Y 3
MEANS +/- 1 sd:		6.35 +/- 1.07	(N = 13)	> 8.33 +/- 0.61	(N = 6)	

TABLE 4. +Gz-tolerance during rapid onset runs while wearing TLSS. Key: Y: data was analyzed; N: not analyzed due to: 1 - data too noisy; 2 - L not recorded; 3 - Data analyzed but too noisy to include in statistical analysis; 4 - Insufficient data obtained during insertion; EOR: end of run.

Subject	Date	Relaxed +Gz-Tolerance	AGSM +Gz-Tolerance	Light Loss	Analyzed?
S1	9/16	8.9	10	65	Y
S1	9/18	7.2	NOT RUN	60	Y
S2	9/17	5.1	8.1	60	Y
S2	9/19	7.5	NOT RUN	60	Y
S3	9/16	5.6	9.0	75	N 1
S3	9/18	4.9	NOT RUN	60-75	Y
S4	9/17	> 10		0	N 2
S5	9/16	> 10 (arm pain)		45	N 2
S6	9/17	5.4	10	60	Y
S7	9/17	7.8	10	60	Y 3
MEANS +/- 1 sd:		> 6.55 +/- 1.49 (N = 8)	> 9.42 +/- 0.86 (N = 5)		

TABLE 5. +Gz-tolerance during gradual onset runs while wearing Combat Edge. Key: Y: data was analyzed; N: not analyzed due to: 1 -data too noisy; 2 - L not recorded; 3 - Data analyzed but too noisy to include in statistical analysis.

Subject	Date	Relaxed +Gz-Tolerance	AGSM +Gz-Tolerance	PLL	Analyzed?
S1	9/17	9.6	10.0	60 (0 @ end)	Y
S1	9/19	9.9	NOT RUN	60	Y
S2	9/16	9.0	10.0	60	Y
S2	9/18	9.6	NOT RUN	60	Y
S3	9/17	5.6	9.2	60	Y
S4	9/16	> 10	NOT RUN	15	Y
S4	9/18	6.8	NOT RUN	60	Y
S4	9/19	8.4	NOT RUN	60	Y
S5	9/17	8.0 (forearm & calf pain)	NOT RUN		N 2
S6	9/16	8.7	NOT RUN	30	N 1
S6	9/18	7.2	NOT RUN	60	Y
S7	9/18	7.7	NOT RUN	75	N 1
MEANS	+/- 1 sd:	8.25 +/- 1.40 (N = 10)	9.73 +/- 0.46 (N = 3)		

TABLE 6. +Gz-tolerance during gradual onset runs while wearing TLSS. Key: Y: data was analyzed; N: not analyzed due to: 1 - data too noisy; 2 - L not recorded.

## RESULTS

1. Calculated stroke volume and cardiac output values were within normal values during pre-run periods and moderate stress loads. Data analyses for these values were focused upon the corresponding stroke and cardiac indices, rather than SV and CO, which account for the effects of individual subject body size.

2. CE data was averaged across subjects at +4 (N=9), 4.5 (N=3), 5 (N=5) and 6 (N=3) Gz. TLSS data was averaged across subjects at +4 (N=10), 5 (N=9), 5.5 (N=3), 6 (N=7), 6.5 (N=4) and 7 (N=3) Gz. Mean data were then compared for suit differences (at +4, 5 and 6 Gz) and for +Gz level differences within each suit. Analyses were performed on the data obtained during the 30 sec +Gz plateau. Note that in this analysis, comparisons between +4 Gz and higher +Gz levels provided an indication of PPB level effects (PPB was supplied at a rate of 12 mmHg/G, in which PPB began to operate at +4 Gz and reached 60 mmHg maximum at +9 Gz).

a. For the first statistical test, the data were grouped according to +Gz-level and compared using t and Mann-Whitney tests in order to determine the overall effect of increased +Gz-stress for each given suit type. Where statistical significance was demonstrated by the t-tests ( $p < 0.05$ ), Mann-Whitney test results were similar ( $z < 0.05$ ). Mean plateau values are given in Table 7. Note that tests were not run using the TLSS +7 Gz PWD or HI data because only 2 sets of subject responses were available. In sum, for almost all comparisons, PWD and  $\Delta$ PWD were not significantly different for either ensemble. HR increased, as well as  $\Delta$ HR, with higher +Gz-loads regardless of which suit

was worn. It was seen that the extent to which HR increased was greater while subjects wore CE rather than TLSS for comparable +Gz-loads. TLSS HI decreased at +6 and 6.5 Gz-load as compared to +4 to +5.5 values. CE HI or  $\Delta$ HI were not significantly changed. TLSS  $\Delta$ HI tended to rise with increasing stress until +6 Gz at which point the increases were smaller (at +6.5,  $\Delta$ HI declined by 5.5%). As +Gz increased, the drop in CE  $\Delta$ SI and  $\Delta$ CI also increased in a linear fashion. For TLSS, the decline in  $\Delta$ SI was actually smaller at +5 and 5.5 Gz. While  $\Delta$ SI dropped to its lowest level at +6 Gz, the decline was less at +6.5 and 7 Gz (+7 Gz SI was not significantly different from +4 to 6 Gz levels). TLSS  $\Delta$ CI also changed in a pattern quite different from CE. +5 Gz  $\Delta$ CI was actually about +2% greater than pre-stress levels.  $\Delta$ CI did drop at +6 Gz and above, though there was no significant difference between +6 to +7 Gz values. In fact, +7 Gz  $\Delta$ CI was indistinguishable from +4 Gz values.

b. The previous section described how the various parameters changed as +Gz-load increased. In an attempt to determine whether those differences were due to +Gz-level or suit type or both, the +4, 5 and 6 Gz data were grouped according to (1) suit worn and (2) +Gz level. These groups were then analyzed using t-test, ANOVA, Fisher's LSD post-hoc test and the Kruskal-Wallis test. The results of the ANOVA are given in Table 8. It was found that CE SI were significantly greater than TLSS values. From the LSD test, the difference in SI values were due to both suit type and +Gz-level. For  $\Delta$ SI, the LSD test indicated that the differences were due to suit type and the difference between +6 Gz values and the +4 and 5 Gz values only. While no differences were demonstrated for  $\Delta$ PWD, based on suit type or stress level, a two-way ANOVA did demonstrate an interaction between the two parameters. This may have been due solely to the increased degrees of freedom associated with this test. T-test results indicated that CE CI was significantly greater than TLSS. However, since the variance of these values was unequal, ANOVA could not be performed. Kruskal-Wallis results did indicate that differences could be attributed to suit type ( $T = 12.79$ , Prob  $CI > T = 0.0003$ ).

+Gz	Suit	PWD s	HR bpm	HI $\Omega$	SI ml/beat	CI L/min	$\Delta$ SI	$\Delta$ CI	$\Delta$ HI	$\Delta$ PWD	$\Delta$ HR
4	CE	0.080 +/- .003	114 +/- 0.7	20.84 +/- 1.08	36.66 +/- 1.70	4.22 +/- 0.18	-17.6% +/- 2.2%	-11.7% +/- 2.5%	15.7% +/- 4.7%	-3.5% +/- 4.9%	7.8% +/- 0.6%
4.5	CE	0.095 +/- .010	115 +/- 4	14.31 +/- 2.35	23.97 +/- 2.10	2.73 +/- 0.32	-23.5% +/- 6.3%	-15.1% +/- 9.4%	2.6% +/- 16.4%	-7.7% +/- 9.5%	12.3% +/- 4.4%
5	CE	0.073 +/- .005	124 +/- 5	22.10 +/- 1.57	43.42 +/- 1.90	5.55 +/- 0.27	-28.0% +/- 1.6%	-17.2% +/- 2.1%	27.4% +/- 7.2%	-15.6% +/- 5.4%	15.0% +/- 4.5%
6	CE	0.075 +/- .014	123 +/- 1	20.82 +/- 4.88	31.92 +/- 1.38	4.13 +/- 0.14	-31.6% +/- 1.3%	-22.6% +/- 0.6%	1.8% +/- 23.8%	-0.4% +/- 18.4%	14.4% +/- 1.1%
4	TLSS	0.081 +/- .008	109 +/- 0.5	22.31 +/- 2.90	34.46 +/- 1.32	3.74 +/- 0.15	-15.3% +/- 4.1%	-10.3% +/- 5.0%	5.4% +/- 13.2%	-3.9% +/- 10.3%	6.0% +/- 0.3%
5	TLSS	0.080 +/- .004	118 +/- 1	22.43 +/- 1.42	31.95 +/- 0.28	3.79 +/- 0.07	-10.8% +/- 0.4%	2.3% +/- 0.5%	14.9% +/- 6.7%	-3.2% +/- 4.4%	14.3% +/- 1.2%
5.5	TLSS	0.080 +/- .008	132 +/- 1	21.74 +/- 3.73	31.99 +/- 2.12	4.23 +/- 0.24	-9.7% +/- 4.8%	-2.3% +/- 4.2%	28.8% +/- 23.1%	-13.6% +/- 7.9%	7.8% +/- 1.0%
6	TLSS	0.076 +/- .002	118 +/- 1	17.99 +/- 0.76	27.40 +/- 2.00	3.22 +/- 0.21	-30.8% +/- 5.3%	-21.8% +/- 4.9%	12.4% +/- 5.0%	-18.6% +/- 3.5%	14.1% +/- 1.2%
6.5	TLSS	0.068 +/- .019	105 +/- 18	15.50 +/- 1.44	21.53 +/- 2.51	2.71 +/- 0.28	-24.6% +/- 3.3%	-21.2% +/- 2.0%	-5.5% +/- 8.6%	-9.7% +/- 6.1%	5.4% +/- 2.7%
7	TLSS	*	128 +/- 3	*	21.63 +/- 2.49	4.15 +/- 0.26	-23.2% +/- 5.3%	-14.7% +/- 5.4%	*	*	11.3% +/- 2.2%

TABLE 7. Mean (+/- 1 standard deviation) cardiac parameters for each +Gz plateau tested for which the number of data points (N) was at least 3 (\* value not listed because N = 2).

Parameter	Factor	F ratio	Prob>F
SI	suit	77.92	0.000
	Gz	45.16	0.000
	suit x Gz	14.91	0.001
$\Delta$ SI	suit	22.88	0.000
	Gz	40.78	0.000
	suit x Gz	13.60	0.001
$\Delta$ PWD	suit	0.22	0.650
	Gz	0.75	0.494
	suit x Gz	4.02	0.046

TABLE 8. Two-way ANOVA results comparing SI,  $\Delta$ SI and  $\Delta$ PWD across 4, 5 and 6 Gz taken as a group for CE and TLSS ensembles.

3. T-tests were run to compare CE versus TLSS at paired +Gz-levels (+4, 5 and 6 Gz - the only groups in which sufficient numbers were available for statistical comparisons). Through these tests, it was possible to demonstrate differences referable to suit type, as shown in Table 9. There were no statistical differences shown in cardiac function between the two suit types at +4 Gz level, except that CE HR was about 5 bpm higher than TLSS and CE CI was about 0.5 L/min/m<sup>2</sup> greater than TLSS. At +5 Gz, while mean SI and CI

values were higher for CE, the corresponding relative changes in these indices for TLSS were significantly smaller. Pulse wave delay was also reduced to a greater extent for subjects wearing the CE garments. At +6 Gz, while no significant differences were demonstrated associated with the normalized cardiac parameters, mean values of CE SI and CI were higher than TLSS.

+Gz	Parameter	t	p <	CE mean value	TLSS mean value
4	$\Delta$ HR	+4.54	0.011	+7.8 +/- 0.6%	+6 +/- 0.3%
4	HR	+11.66	0.0003	114 +/- 0.7	109 +/- 0.5
4	CI	+3.58	0.023	4.22 +/- 0.18	3.74 +/- 0.15
5	$\Delta$ SI	-17.92	0.0004	-28 +/- 1.6%	-10.8 +/- 0.4%
5	$\Delta$ CI	-15.63	0.004	-17.2 +/- 2.1%	-2.3 +/- 0.5%
5	$\Delta$ PWD	-3.07	0.037	-15.6 +/- 5.4%	-3.2 +/- 4.4%
5	SI	+10.98	0.008	43.42 +/- 1.90	31.95 +/- 0.28
5	CI	+11.17	0.008	5.55 +/- 2.07	3.79 +/- 0.07
6	SI	+3.74	0.020	31.92 +/- 1.38	27.40 +/- 2.0
6	CI	+6.28	0.003	4.13 +/- 0.14	3.22 +/- 0.21
6	HR	+2.95	0.042	123 +/- 1.2	118 +/- 1.3

TABLE 9. T-test statistical differences comparing CE to TLSS cardiac parameters calculated at +4, 5 and 6 Gz. Values are mean +/- 1 standard deviation.

4. In order to interpret how subject cardiac physiology responded to increased PPB levels at higher +Gz-loads for each ensemble, t-tests were conducted comparing mean +4 Gz values (stressed, though PPB still inactive) to +4.5, 5 and 6 (for CE) and to +5, 5.5, 6, 6.5 and 7 Gz (for TLSS) (see Table 10). For CE, the decline in  $\Delta$ SI and  $\Delta$ CI was significantly greater at +5 and 6 Gz as compared to +4 Gz values. The increase in heart rate at +6 Gz was significant relative to +4 Gz. The change in pulse wave delay was smaller at +5 Gz as compared to +4 Gz. For TLSS, the comparisons indicated the following. As expected, as +Gz-load increased, there was a drop in SI and CI. The relative decline in  $\Delta$ SI and  $\Delta$ CI increased at +6 and 6.5 Gz, though there was a slight increase in  $\Delta$ CI at +5 Gz. However, when the PPB level reached 36 mmHg at +7 Gz, the difference in  $\Delta$ SI and  $\Delta$ CI relative to +4 Gz values was not significant (+7 Gz  $\Delta$ SI = -23.2%, t = 2.03, p < 0.112 and  $\Delta$ CI = -14.7%, t = 1.03, p < 0.362). As with CE values, TLSS heart rate did rise as +Gz-load increased but the relative changes in heart rate at the various +Gz levels were not significant. Comparisons which proved statistically significant are shown in Table 10.

Suit	+Gz	Parameter	t	p <	+4 Gz value	+Gz value
CE	5.0	$\Delta$ SI	6.67	0.003	-17.6 +/- 2.2%	-28 +/- 1.6%
CE	6.0	$\Delta$ SI	9.70	0.001	-17.6 +/- 2.2%	-31.6 +/- 1.3%
CE	5.0	$\Delta$ CI	2.91	0.044	-11.7 +/- 2.5%	-17.2 +/- 2.1%
CE	6.0	$\Delta$ CI	7.20	0.019	-11.7 +/- 2.5%	-22.6 +/- 0.6%
CE	5.0	$\Delta$ PWD	2.85	0.046	-3.5 +/- 4.9%	-15.6 +/- 5.4%
CE	6.0	$\Delta$ HR	-9.43	0.001	+7.8 +/- 0.6%	+14.4 +/- 1.1%
CE	4.5	SI	8.13	0.001	36.66 +/- 1.7	23.97 +/- 2.10
CE	5.0	SI	-4.59	0.010	36.66 +/- 1.7	43.42 +/- 1.90
CE	6.0	SI	3.86	0.018	36.66 +/- 1.7	31.92 +/- 1.38
CE	4.5	CI	7.16	0.002	4.22 +/- 0.18	2.73 +/- 0.32
CE	5.0	CI	-7.20	0.002	4.22 +/- 0.18	5.55 +/- 0.27
CE	4.5	HI	4.37	0.012	20.84 +/- 1.08	14.31 +/- 2.35
CE	6.0	HR	-10.92	0.0004	114 +/- 0.7	123 +/- 1.2
TLSS	6.0	$\Delta$ SI	4.01	0.016	-15.3 +/- 4.1%	-30.8 +/- 5.3%
TLSS	6.5	$\Delta$ SI	3.06	0.038	-15.3 +/- 4.1%	-24.6 +/- 3.3%
TLSS	5.0	$\Delta$ CI	-4.35	0.049	-10.3 +/- 5.0%	+2.3 +/- 0.5%
TLSS	6.0	$\Delta$ CI	2.84	0.047	-10.3 +/- 5.0%	-21.8 +/- 4.9%
TLSS	6.5	$\Delta$ CI	3.48	0.040	-10.3 +/- 5.0%	-21.2 +/- 2.0%
TLSS	6.0	SI	5.10	0.007	34.46 +/- 1.32	27.40 +/- 2.00
TLSS	6.5	SI	7.92	0.001	34.46 +/- 1.32	21.53 +/- 2.51
TLSS	5.5	CI	-2.97	0.041	3.74 +/- 0.15	4.23 +/- 0.24
TLSS	6.0	CI	3.49	0.025	3.74 +/- 0.15	3.22 +/- 0.21
TLSS	6.5	CI	5.58	0.005	3.74 +/- 0.15	2.71 +/- 0.28
TLSS	5.0	HR	-13.22	0.001	109 +/- 0.5	118 +/- 1.2
TLSS	6.0	HR	-8.57	0.013	109 +/- 0.5	118 +/- 1.3
TLSS	6.5	HR	-8.79	0.013	109 +/- 0.5	105 +/- 17.5
TLSS	7.0	HR	-12.11	0.007	109 +/- 0.5	128 +/- 2.6

TABLE 10. Statistically significant differences (t-test) found when comparing +4 Gz responses to higher +Gz levels for subjects wearing CE and TLSS. Values are mean +/- 1 standard deviation.

5. In an attempt to study physiologic responses at similar physiologic stress levels, cardiac parameters taken at each subject's ROR +Gz-tolerance level during the 30 sec plateau were grouped for comparison based on suit type. These levels varied between and within subjects as shown in Tables 3 and 4. For this analysis, unpaired t-tests Mann-Whitney Two Sample tests and were conducted comparing individual subject data. The corresponding subject data is given in Table 11. Based on t-test comparisons performed on all subjects as a group, there were no significant differences in cardiac parameters between the two suit types alone, though the Mann-Whitney test suggested that CE CI was significantly greater than TLSS ( $t = 1.35$ ,  $p < 0.184$  and  $z = 6.27$ , Prob  $|z| > z = 0.000$ ). CE  $\Delta$ HR was greater than TLSS even though subjects wearing the TLSS garment had higher +Gz-tolerance levels than when they wore the CE ensemble ( $t = 2.66$ ,  $p < 0.015$  and  $z = 2.25$ , Prob  $|z| > z = 0.025$ ).

Subject	Suit	Date	+Gz	HI	SI	CI	$\Delta$ HI	$\Delta$ SI	$\Delta$ CI
S1	CE	9/18	5.0	26.37 +/- 5.40	70.91 +/- 11.52	9.40 +/- 1.60	97.5 +/- 20.0%	-25.7 +/- 12.1%	-14.7 +/- 14.5%
S1	CE	9/16	6.5	20.51 +/- 4.97	53.11 +/- 6.67	7.66 +/- 0.63	-0.5 +/- 24.1%	-38.7 +/- 7.7%	-27.5 +/- 6.0%
S1	TLSS	9/17	8.0	?	50.68 +/- 3.44	7.22 +/- 0.74	?	-31.4 +/- 4.6%	-16.6 +/- 8.6%
S2	CE	9/19	4.5	14.89 +/- 4.48	19.72 +/- 3.89	2.26 +/- 0.52	-1.3 +/- 3.0%	-40.8 +/- 11.7%	-24.2 +/- 17.4%
S2	CE	9/17	5.5	24.33 +/- 0.35	45.3 +/- 8.16	6.21 +/- 0.95	-11 +/- 2.0%	-36.2 +/- 11.5%	-19.5 +/- 12.3%
S2	TLSS	9/16	6.5	22.12 +/- 1.59	24.67 +/- 0.18	3.00 +/- 0.17	18.9 +/- 8.6%	-28 +/- 0.6%	-25.6 +/- 4.2%
S2	TLSS	9/18	7.5	19.54 +/- 1.96	17.80 +/- 1.59	2.44 +/- 0.26	11.1 +/- 11.1%	-37.5 +/- 5.6%	-29.3 +/- 7.6%
S3	CE	9/18	4.0	21.62 +/- 0.11	29.77 +/- 14.0	3.53 +/- 0.27	19.5 +/- 0.7%	0.2 +/- 4.7%	-6.1 +/- 8.2%
S3	CE	9/16	4.5	13.00 +/- 3.04	32.04 +/- 6.88	3.44 +/- 0.96	-4.7 +/- 22.3%	-4.5 +/- 2.1%	0.1 +/- 27.8%
S3	TLSS	9/19	5.5	17.23 +/- 1.34	27.52 +/- 3.97	3.18 +/- 0.40	-12.3 +/- 68.0%	-33.2 +/- 9.7%	-30 +/- 8.8%
S3	TLSS	9/17	6.5	13.04 +/- 3.81	26.22 +/- 9.59	2.81 +/- 0.86	-38.1 +/- 18.1%	-55.7 +/- 16.2%	-52.6 +/- 14.6%
S4	TLSS	9/16	5.5	18.42 +/- 2.80	26.22 +/- 1.43	3.83 +/- 0.19	-6.7 +/- 16.2%	10.4 +/- 6.1%	22.4 +/- 6.2%
S4	TLSS	9/18	5.5	29.59 +/- 7.64	42.23 +/- 2.93	5.68 +/- 0.47	91.9 +/- 49.3%	-6.4 +/- 6.5%	0.7 +/- 8.4%
S4	TLSS	9/19	6.5	22.43 +/- 6.56	27.32 +/- 1.00	4.16 +/- 0.11	-2.9 +/- 2.8%	-14.8 +/- 3.2%	-6.6 +/- 2.4%
S5	TLSS	9/20	6.0	15.83 +/- 3.35	29.95 +/- 3.25	3.16 +/- 0.19	15.2 +/- 24.4%	2.8 +/- 11.2%	6.3 +/- 6.5%
S6	CE	9/17	4.5	15.05 +/- 4.24	20.15 +/- 0.62	2.48 +/- 0.02	13.9 +/- 32.0%	-25.1 +/- 2.3%	-21.3 +/- 1.5%
S6	CE	9/19	6.0	15.23 +/- 2.07	50.43 +/- 1.12	5.13 +/- 0.17	-29.6 +/- 9.6%	-56.4 +/- 2.8%	-50.5 +/- 4.4%
S6	TLSS	9/18	6.5	22.94 +/- 7.00	17.41 +/- 2.39	2.05 +/- 0.33	58.3 +/- 48.3%	-35.2 +/- 8.9%	-31.7 +/- 11.1%

TABLE 11. Cardiac indices averaged (+/- 1 standard deviation) during 30 sec plateau at each subject's +Gz-tolerance level. ? = ECG quality too poor to calculate HI; \* = S5 CE runs terminated prematurely due to arm pain.

Individual subject responses were also tested at their +Gz-tolerance levels. The only difference based on suit type found for Subject S1 was that TLSS tolerance HR was greater than for CE. For Subject S2, TLSS  $\Delta$ HI actually increased at plateau and the drop in CE  $\Delta$ PWD was smaller and PWD was larger than TLSS. There was a greater increase in  $\Delta$ HR for CE as compared to TLSS. The drop in  $\Delta$ HI,  $\Delta$ SI,  $\Delta$ PWD and  $\Delta$ CI for Subject S3 were greater when he wore TLSS as compared to CE. This result may be misleading given the higher +Gz and PPB levels S3 reached with TLSS. As was seen for Subject S2, TLSS  $\Delta$ HI for Subject S6 also increased at plateau. His CE HR was also

greater than his TLSS tolerance HR. Statistically significant t-test and Mann-Whitney results are given in Table 12.

Subject	Parameter	t	t <	z	Prob  z  > z
S1	HR	-2.38	0.049	-0.90	0.366
S2	$\Delta$ PWD	3.79	0.004	2.40	0.016
S2	$\Delta$ HR	5.30	0.0003	2.88	0.004
S2	$\Delta$ HI	-2.37	0.045	-1.92	0.055
S2	PWD	2.91	0.023	2.56	0.010
S3	$\Delta$ SI	4.74	0.001	2.72	0.007
S3	$\Delta$ CI	4.38	0.001	2.72	0.007
S3	$\Delta$ HI	2.97	0.014	2.08	0.037
S3	$\Delta$ PWD	2.60	0.026	1.84	0.066
S6	HR	4.08	0.005	0.26	0.796
S6	$\Delta$ HI	-2.51	0.041	-1.81	0.071
S6	HI	-1.85	0.162	-2.07	0.039

TABLE 12. Statistically significant differences comparing CE vs TLSS (based on suit type not +Gz-level) for individual subjects at their +Gz-tolerance levels using t and Mann-Whitney tests.

6. Data obtained from ROR's which were terminated due to 60° or greater PLL were subjected to t-test and one-way ANOVA to determine potential suit differences. This data set consisted of the pre-run, recovery and, typically, one data point at +Gz plateau (60° PLL typically occurred by 10 sec at plateau). No statistical differences could be demonstrated.

Another method to compare subject responses at a similar physiologic stress level, was to investigate responses based on PLL levels (e.g. group data from 0° to 29°, from 30° to 44° and from 45° to 59°). Unfortunately, there were insufficient data at different light loss classes to conduct valid statistical tests. Most of the subjects experienced 0° PLL up until the G-tolerance run or when the run was ended due to PLL > 60°.

7. Relaxed GOR's are typically run to allow for subject cardiac reflexes to be fully activated before reaching high levels of stress. To investigate cardiac responses based on suit differences during relaxed GOR, individual subject responses for CE vs TLSS over the same time at G were compared using t-tests. Sufficient data for tests was available for subjects S1, S2, S3 and S6. Two CE runs for S2 were compared against S2's one TLSS run set, likewise for S1. For Subject S1, the drop in TLSS  $\Delta$ SI and  $\Delta$ CI were marginally greater than for CE ( $t = -2.05$ ,  $p < 0.056$  and  $t = -2.09$ ,  $p < 0.051$ , respectively). For subjects S2, S3 and S6, relaxed GOR responses could be compared for the period between +2 and 5 Gz. Data was also available for subject S2 between +2 and +8 Gz. All statistically significant tests results are given in Table 13 (not statistically significant results are omitted).

These tests indicated that only Subject S2's CE  $\Delta$ CI was significantly larger than his TLSS values. For all subjects,  $\Delta$ SI values were indistinguishable between the two suits. The results in Table 13 seem to indicate that at lower +Gz-loads, CE  $\Delta$ HI was greater than TLSS. If one averages  $\Delta$ HI at each +Gz level from +2 to 7 Gz for all subjects, the relative change in CE HI was consistently greater than TLSS (an approximately 33% increase vs a 7% rise, respectively). The relative stability of TLSS  $\Delta$ HI may be due to the greater body coverage it has as compared to CE. Heart rate was also greater while wearing the CE as compared to the TLSS ensemble.

Subject	+Gz range	Parameter	t	p <	Mean CE value	Mean TLSS value
S2	2 -5	$\Delta$ CI	2.61	0.023	10.3 +/- 19.7%	-16.6 +/- 23.0%
S2	2 -8	$\Delta$ CI	2.21	0.040	3.6 +/- 28.0%	-19.3 +/- 19.0%
S1	2 -7	CI	2.66	0.016	11.33 +/- 3.25	8.24 +/- 1.67
S2	2 -5	CI	3.38	0.007	5.46 +/- 1.15	3.62 +/- 0.98
S3	2 -5	CI	-4.63	0.004	4.03 +/- 0.48	5.95 +/- .068
S2	2 -5	SI	3.66	0.004	44.91 +/- 9.04	30.15 +/- 6.99
S3	2 -5	SI	-5.45	0.002	33.55 +/- 3.91	54.38 +/- 6.58
S2	2 -8	$\Delta$ HI	-4.16	0.001	-16.3 +/- 12.7%	27.4 +/- 0.35%
S3	2 -5	$\Delta$ HI	4.30	0.005	38.6 +/- 8.5%	4.3 +/- 13.5%
S2	2 -8	HI	-6.47	0.000	16.68 +/- 2.54	29.12 +/- 6.02
S2	2 -8	$\Delta$ PWD	6.56	0.000	4.3 +/- 5.3%	-23.7 +/- 14.0%
S6	2 -5	$\Delta$ PWD	-2.51	0.046	-34.9 +/- 13.1%	-8.3 +/- 16.7%
S2	2 -8 a	PWD	6.28	0.000	0.083 +/- 0.004	0.062 +/- 0.011
S2	2 -8	$\Delta$ HR	4.07	0.020	46.6 +/- 15.9%	17.8 +/- 12.6%
S2	2 -8 a	$\Delta$ HR	5.64	0.0001	46.6 +/- 15.9%	4.3 +/- 11.9%
S6	2 -5	$\Delta$ HR	5.43	0.002	21.0 +/- 4.1%	-0.80 +/- 6.9%
S3	2 -5	HR	3.60	0.011	120 +/- 4.4	110 +/- 3.9
S6	2 -5	HR	4.22	0.006	124 +/- 4.3	106 +/- 7.4

TABLE 13. Statistically significant t-test results for individual subject responses while wearing CE as compared to TLSS during relaxed GOR. Values are mean +/- 1 standard deviation. a = compared 9/16 TLSS to 9/19 CE data.

8. The data in Appendix A, which contain the individual subject responses while wearing either ensemble, illustrate that there was, as expected, a good deal of individual variability. For CE, there was a decline in stroke volume and cardiac output (on average, about 33 and 23% less than pre-run levels at +6 Gz-load, respectively) with an increase in heart rate. For TLSS, the drop in stroke volume and cardiac output reached a minimum at +6 Gz (on average, about 37 and 27% less than pre-run levels, respectively), then there was an improvement at +6.5 Gz and above. When interpreting these data in order to compare how the heart may have responded differently while subjects wore either ensemble, it is important to note that only with the TLSS garment did subjects achieve sufficient +Gz-loads to receive PPB levels above 30 mmHg (only subject S5 on 9/19 completed 30 sec above +6 Gz). With that in mind, based on trends across all subjects

after 30 sec at plateau during relaxed ROR's (at +4 Gz and higher), the following observations are presented:

a.  $\Delta$ CI: For subjects wearing CE, the greater the +Gz-load, the greater the decrement in  $\Delta$ CI as compared to pre-run values. For TLSS runs, however, this relationship was not nearly as linear. The drop in  $\Delta$ CI was slightly less at +5 and 5.5 Gz than at +4 Gz (within  $\pm 4\%$  of pre-stress levels).  $\Delta$ CI reached a minimum at +6 Gz (33% lower than pre-stress) and then rose above +6.5 Gz. At +7 Gz, the drop in  $\Delta$ CI is 21% lower than pre-stress while at +4 Gz, the decline in  $\Delta$ CI is 12%. This trend was seen for all subjects wearing TLSS except for subject S3, who demonstrated a decline in  $\Delta$ CI as +Gz load increased. For subjects wearing CE, 5 of 9 data sets had the lowest drop or even a slight increase in cardiac index at +4 to 4.5 Gz.

b.  $\Delta$ SI: As expected, the change in stroke index followed basically the same pattern as  $\Delta$ CI for CE and TLSS. CE  $\Delta$ SI declined as +Gz-load increased. The reduction in TLSS mean  $\Delta$ SI after 30 sec at plateau reached a minimum at +5.5 Gz (6% lower than pre-stress), a maximum at +6 Gz (42% lower than pre-stress), then it improved at +6.5 Gz and above.

c. CO: Overall, when subjects wore CE, as +Gz-load increased, cardiac output fell. In 4 of 8 data sets, however, CO was greater at +5 or +6 Gz than at +4 Gz (on the order of 1 L/min). When they wore TLSS, on average, the peak CO occurred at +5.5 Gz, the minimum at +6 Gz, following by an increase in CO as +Gz-load rose above +6 Gz. For 8 of 10 TLSS data sets, CO after 30 sec at +Gz-tolerance levels was within  $\pm 20\%$  of each subject's +4 Gz CO. For subjects wearing CE, however, there was a much greater variability in this relationship in that the difference between +Gz-tolerance CO and +4 Gz CO ranged from a 75% drop (subject S6) to a 43% increase (subject S1). There was considerable variability between subjects. For example, while TLSS CO steadily declined for subject S3 with increasing +Gz, subject S1's highest CO occurred at her tolerance level of +8 Gz. Mean cardiac output for all subjects wearing CE after 30 sec at plateau ranged from approximately 5.3 to 9.7 L/min and the range for TLSS was from about 5.1 to 7.8 L/min. From +4 to +6 Gz, CE CO was about 21% higher than TLSS.

d. SV: As with CO, subjects wearing CE experienced greater reductions in stroke volume as +Gz-load increased. Unlike CE CO, for 6 of 8 data sets, the greatest SV was at +4 to +4.5 Gz. For subjects wearing TLSS, the largest SV's were measured at +4 and 5 Gz (except for subjects S1 and S2). There was no linear decrease in SV with increasing +Gz level as seen with the CE data. Mean SV at +4 and +5.5 were essentially equal (61.4 and 60.2 ml/beat, respectively). Minimum SV occurred at +6 to 6.5 Gz followed by an increase at +7 Gz. In fact there was only a 20% difference between mean +4 Gz SV and +7 Gz. Mean stroke volume for all subjects wearing CE after 30 sec at plateau ranged from approximately 45.2 to 74.2 ml/beat and the range for TLSS was from about 40.2 to 61.4 ml/beat.

e. HR: For both ensembles, heart rates increased with increased +Gz-load. After 30 sec, mean HR while wearing CE ranged from 114 to 127 beats/min and for TLSS, rates ranged from 110 to 127 beats/min, for +4 Gz to +Gz-tolerance levels, respectively. For +4 to +6 Gz, CE HR was slightly higher than TLSS (from 4 to 10 bpm).

f.  $\Delta$ HI: When subjects wore CE, the mean change in cardiac contractility after 30 sec at plateau increased as +Gz-load increased. Mean  $\Delta$ HI ranged from +20% at +4 Gz to +28% at +6 Gz. For subjects wearing TLSS, however,  $\Delta$ HI varied by only +/- 10% with respect to pre-stress levels as +Gz-load ranged from +4 to +6.5 Gz. At +7 Gz, there was a jump in TLSS  $\Delta$ HI to +30%.

g.  $\Delta$ PWD: In general, for both CE and TLSS runs, as +Gz-load increased, the pulse wave delay decreased. At +4 to 5 Gz, TLSS PWD was the same as pre-stress levels. At +5.5 Gz and above,  $\Delta$ PWD was 10 to 24% shorter than pre-stress values (minimum  $\Delta$ PWD occurred at +6 Gz). For TLSS,  $\Delta$ PWD ranged from a mean high of +2% to a low of -24%. For CE,  $\Delta$ PWD ranged from +1% to -21%.

9. In a study on the effects of PPB and AGSM in miniature swine, Burns et al<sup>1</sup> reported changes in chronically measured left and right ventricular stroke volume (LVSV and RVSV, respectively) and cardiac output (LVCO and RVCO, respectively) during GOR to +9 Gz. The swine in this study wore an extended coverage anti-G suit, which included a counter pressure jerkin and coverage over the abdomen and rear legs down to the feet. Under +Gz-stress, swine strain spontaneously. The relative drop in these indices was similar to the calculated human mean  $\Delta$ SI and  $\Delta$ CI, as shown below, given that the human subjects did not perform AGSM or reach PPB pressures of 60 mmHg, as did the swine at +9 Gz. In this study, the swine also wore an anti-G suit with only an abdominal bladder (AbAGS). Burns suggested that the improvement in cardiac performance of the ECGS vs the AbAGS in the swine was due to the increased peripheral resistance associated with the ECGS.

Subject	+Gz	Suit	$\Delta$ SV	$\Delta$ CO	$\Delta$ LVSV	$\Delta$ RVSV	$\Delta$ LVCO	$\Delta$ RVCO
Human	9	TLSS	-39%	-18%				
Human	7	CE	-38%	-16%				
Swine	9	ECGS			-33%	-25%	-52%	-32%

Table 14. Mean change in stroke volume and cardiac output for human subjects at the end of relaxed GOR exposures as compared to mean values chronically measured on miniature swine as reported by Burns et al<sup>1</sup>.

## DISCUSSION

A rise in cardiac contractility is typically caused by increased stretch in the cardiac muscles, as described by the Frank-Starling Law<sup>5</sup>. Under normal circumstances, if end diastolic volume increases, myocardial fibers are stretched to a larger extent which leads to a more forceful contraction to expel the increased volume. Based on the Starling effect alone, the drop in venous return caused by blood pooling in an unprotected individual exposed to +Gz-stress should be accompanied by a decline in contractility. Yet in response to +Gz-stress, heart rate increases. This is due to an extrinsic autonomic control mechanism which increases sympathetic stimulation to the heart thereby producing a dual effect: (1) myocardial excitability increases which reduces the conduction time for nervous

impulses to travel through the atrioventricular node and (2) the force of cardiac contractility increases which leads to more complete emptying of the ventricles during systole - hence a lower end systolic volume<sup>5</sup>. For these intrinsic and extrinsic control mechanisms to function properly under adverse conditions, total peripheral resistance must be augmented to maintain cardiac output and systemic blood pressure.

The effects of increasing lower limb coverage during PPB were summarized in an article by Glaister<sup>3</sup>. In it he presented data which indicated that as limb coverage was increased, the PPB-induced rise in systemic arterial pressure was augmented in a somewhat linear fashion. (Note that when comparing body coverage between CE and TLSS, abdominal and thoracic coverage are the same while the TLSS garment provides 45% greater leg bladder coverage.) Glaister explained that this phenomenon was caused by an interaction between the central blood volume receptors and the intrathoracic and carotid sinus baroreceptors. As peripheral venous pressure rises due to blood pooling, the carotid sinus baroreceptors sense the increase in blood pressure and induce a reflex bradycardia. However, since the pressures inside and outside of the aorta rise concurrently, the output from these receptors will conflict with the carotid sinus baroreceptor and lead to an overall rise in systemic pressure.

Unfortunately, blood pressure measurements were not be made during these experiments due to technical problems with the device. Given this limitation in the data set, and the results listed above, the following conjecture can be made. With sufficient counter pressure on the limbs and thorax during PPB, it is possible to assist cardiac efficiency by reducing the amount of blood displaced from the chest and by increasing the effective right atrial pressure<sup>2</sup>, though to a level that is below unstressed values.

From Tables 7 and 9, it was shown that while CE SI and CI were greater than TLSS at loads up to +6 Gz, there relative decline in these indices ( $\Delta SI$  and  $\Delta CI$ ) were smaller with the TLSS ensemble as compared to the CE. Table 8 indicated that this difference could be attributable to the suit type for  $\Delta SI$  and +Gz level. Table 9 shows that TLSS  $\Delta SI$  and  $\Delta CI$  were significantly smaller at +5 Gz. For TLSS (see Figures 29-32),  $\Delta SI$  and  $\Delta CI$  fall to a minimum at +6 Gz, then the decline in these indices was reduced with higher breathing pressure (30 mmHg and above). Of greater interest was the finding that there was no statistical difference between +4 and +7 Gz TLSS  $\Delta SI$  and  $\Delta CI$ . One could infer that the addition of 36 mmHg in the TLSS ensemble enabled the heart to function at a level commensurate with much lower stress levels. Table 10 showed that these changes were significant when comparing 0 mmHg values to 24 and 30 mmHg data. For the CE data (see Figures 19-22), mean  $\Delta SI$  and  $\Delta CI$  fell as the +Gz-load increased. As compared to 0 mmHg values (at +4 Gz), these declines in  $\Delta SI$  and  $\Delta CI$  were significant for PPB levels up to 24 mmHg.

There was an apparent difference in the way cardiac contractility changed between the suits as well. As shown in Figure 33, while mean TLSS  $\Delta HI$  increased as +Gz stress was applied at all levels tested, the range was only approximately +/- 10% after 30 seconds at plateau, except for +5.5 and 7 Gz values. For CE data (Figure 23),  $\Delta HI$

increased by at least 20% after 30 sec at plateau up to +6 Gz. There was not the consistency in the CE data as there was in the TLSS. Of interest in a discussion of  $\Delta HI$ , were the results calculated during GOR exposures. From the results listed in Table 13, it appeared that at higher +Gz-load and PPB levels,  $\Delta HI$  for subjects wearing TLSS increased, while they decreased when wearing the CE ensemble. The opposite was true at lower (+5 Gz and below) +Gz-loads.

From Figures 27 and 37, it was shown that TLSS and CE  $\Delta PWD$  shortened as +Gz-load increased, probably as a function of the increased heart rate. Note that from Tables 7 and 9, HR associated with wearing CE was higher than with TLSS. While a statistical difference was demonstrated at +4 and +6 Gz, the difference of about 5 bpm is not operationally significant.

It was presumed that comparisons across the subjects taken at their respective +Gz-tolerance levels would represent a similar physiologic state. While it could be demonstrated that there was a significant difference in heart rate at tolerance between the two suits, probably due to the fact that individuals had a greater +Gz-tolerance with TLSS than CE, no other differences in cardiac indices were found. When individual subject responses were compared for differences based on suit type, the only consistent index for these subjects was  $\Delta HI$ . Table 12 shows that CE  $\Delta HI$  decreased while TLSS  $\Delta HI$  increased for subjects S2 and S6 at their +Gz-tolerance levels. For subject S3, the reverse was true.

The body's various regulatory systems are designed to compensate for wide variations in physiologic stresses in order to maintain as close to "normal" operating levels as possible. Typically this involves a balance between overcompensation and undercompensation in the fashion of a damped second order system. Protective gear that can in effect increase the damping factor of these systems should afford individuals an increased ability to withstand these stresses over longer exposure times. It may have been an advantage for this subject pool to wear the TLSS, as opposed to the CE, ensemble which allowed individuals to achieve a more consistent level of cardiac contractility along with a smaller increase in heart rate as +Gz-stress rose over the entire insertion period.

Furthermore, it may be postulated that, at least for some of the subject pool, the TLSS garment was more effective at compensating for the loss of venous return to the heart than the CE ensemble once PPB reached at least 30 mmHg (at the +6.5 Gz level) by reducing the drop in SI and CI. Also, the magnitude of  $\Delta SI$  and  $\Delta CI$  were relatively smaller for TLSS as compared to CE. Therefore, even though the absolute value of SI and CI were greater with the CE, the TLSS garment was apparently able to limit the reduction in ventricular volume more effectively. The combination of a more consistent level of cardiac contractility and stroke volume enabled the ventricles to be as forcefully and completely emptied as possible even though there was less blood in the heart. These factors along with a higher heart rate and increased lower limb coverage, which led to an assumed higher peripheral arterial and atrial pressure, may have led to the increased +Gz-tolerance levels obtained when subjects wore the TLSS ensemble.

Maintenance of cardiac filling results from a balance between the increased intrathoracic pressure tending to reduce venous return to the heart and the efficiency of lower body counterpressure as it acts to increase effective blood volume in the torso by forcing blood out of the extremities. The key question then is to determine what the optimal balance should be between these two pressures with the caveat that the combined pressures should be at a comfort level acceptable to aircrew. Therefore, it is essential in future studies to meaningfully compare garments like these during application of +Gz-stress, total peripheral resistance must be calculated. The following formula may be used<sup>6</sup>:

$$\text{Total peripheral resistance} = \text{MAP} / \text{CO}$$

where, mean arterial pressure (MAP) =  $1/3 \text{ SBP} + 2/3 \text{ DBP}$ ; SBP = systolic blood pressure and DBP = diastolic blood pressure.

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7. Global Lab v2.1, 1991. Data Translation, Inc., 100 Locke Dr., Marlboro, MA 01752-1192.

FIGURE 1. Change in Cardiac Index for Subject S1 During +Gz-Tolerance Runs

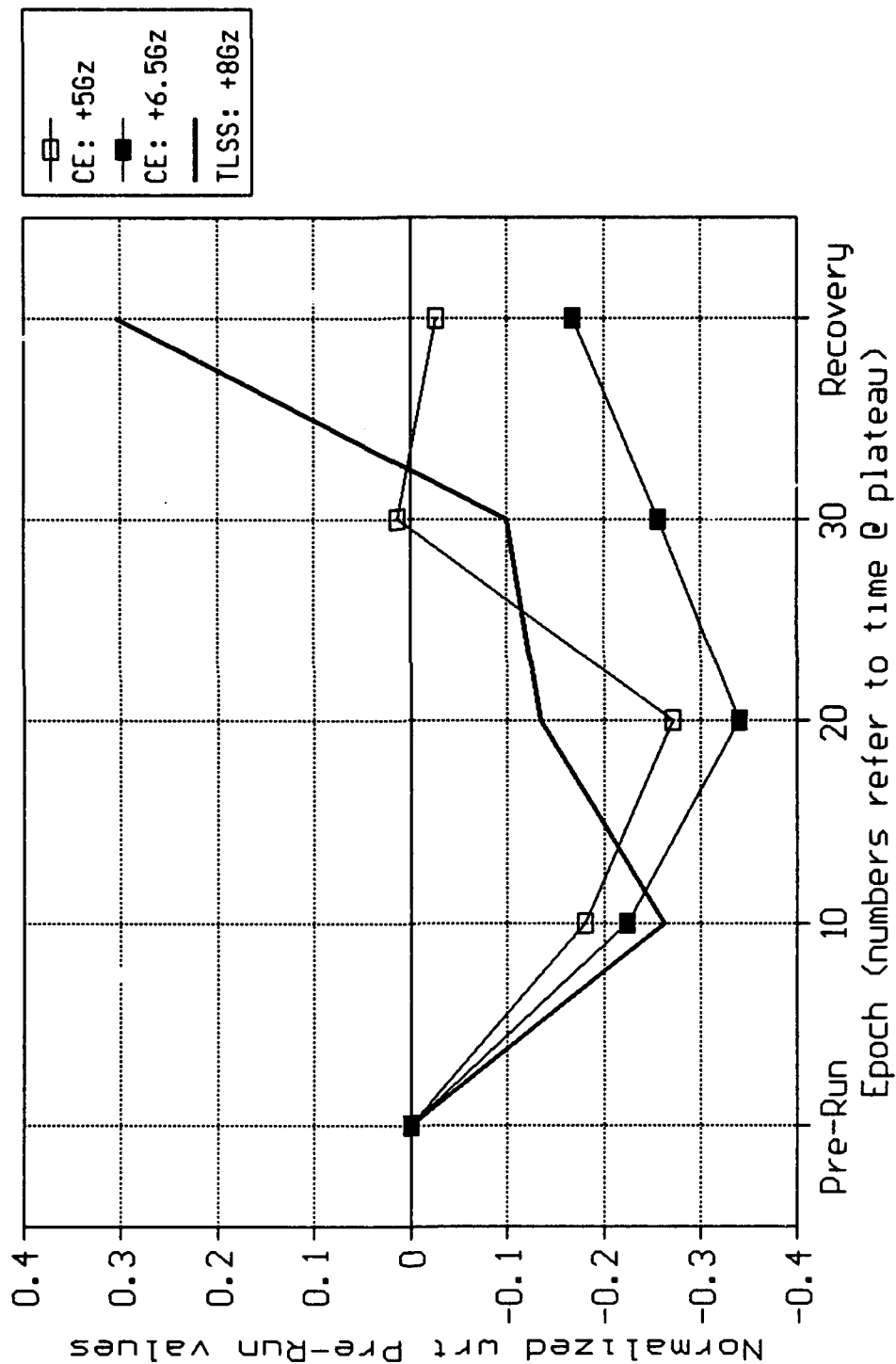


FIGURE 2. Change in Cardiac Index for Subject S2 During +Gz-Tolerance Runs

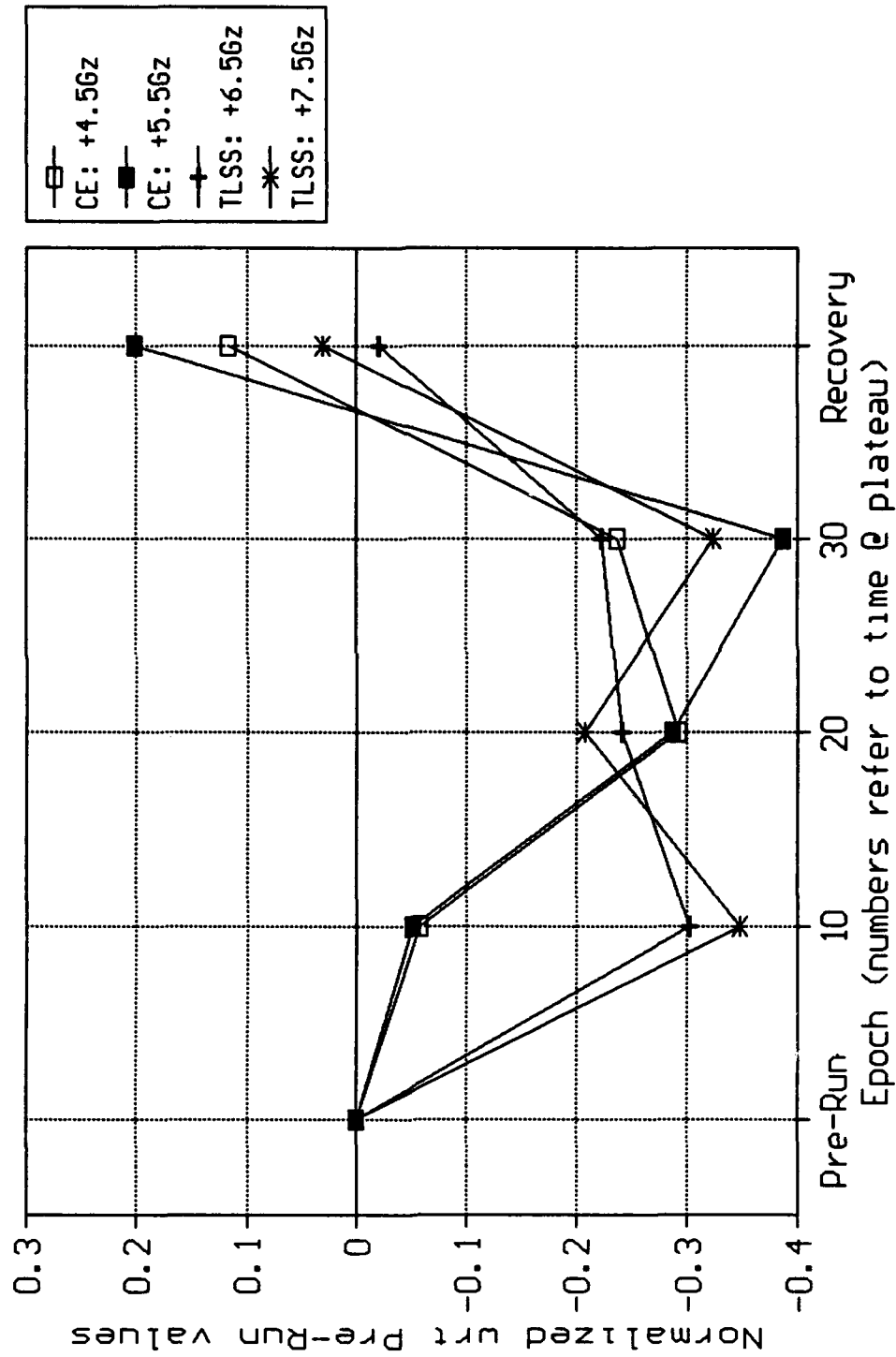


FIGURE 3. Change in Cardiac Index for Subject S3 During +6z-Tolerance Runs

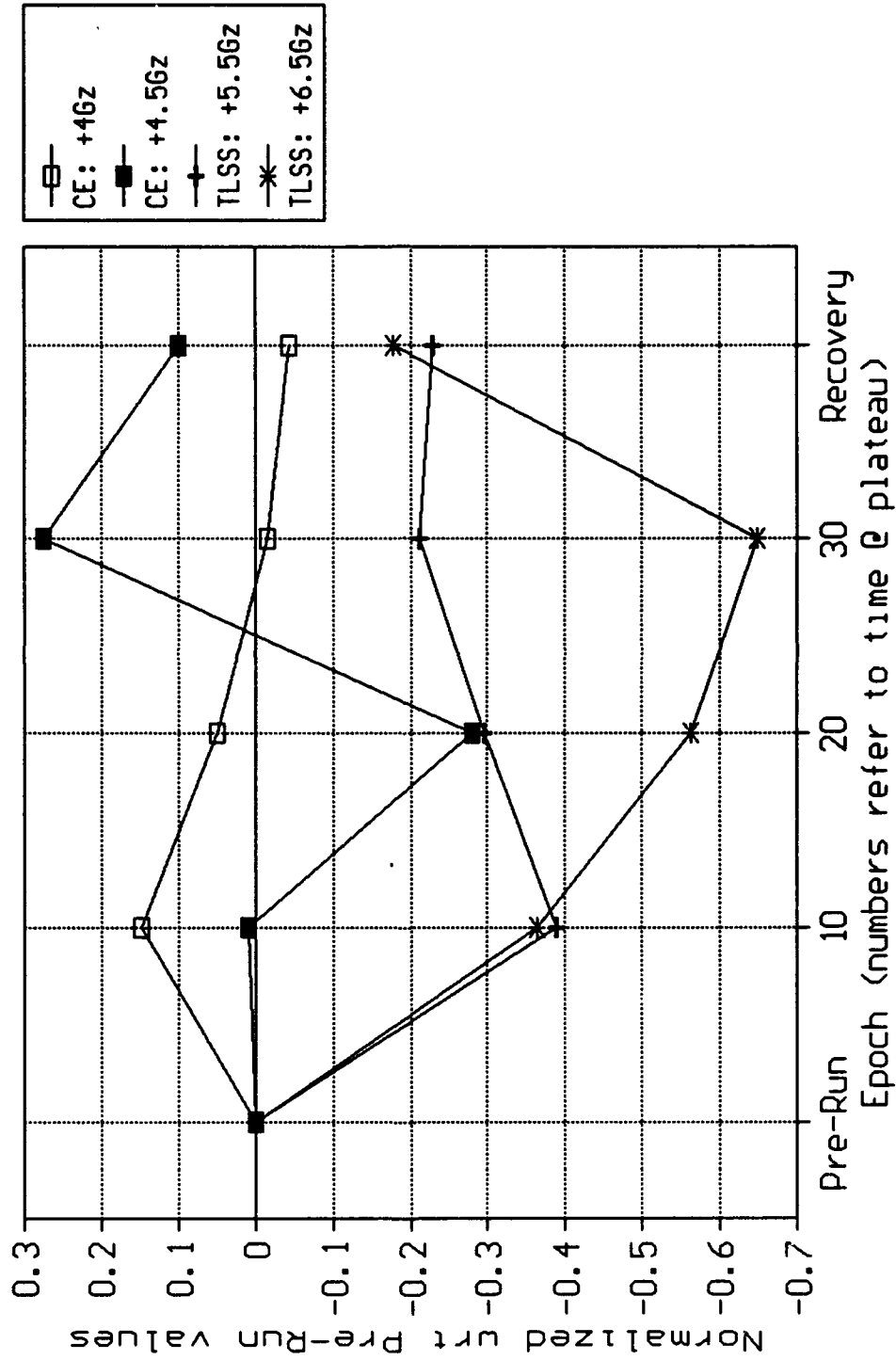


FIGURE 4. Change in Cardiac Index for Subject S6 During +6g-Tolerance Runs

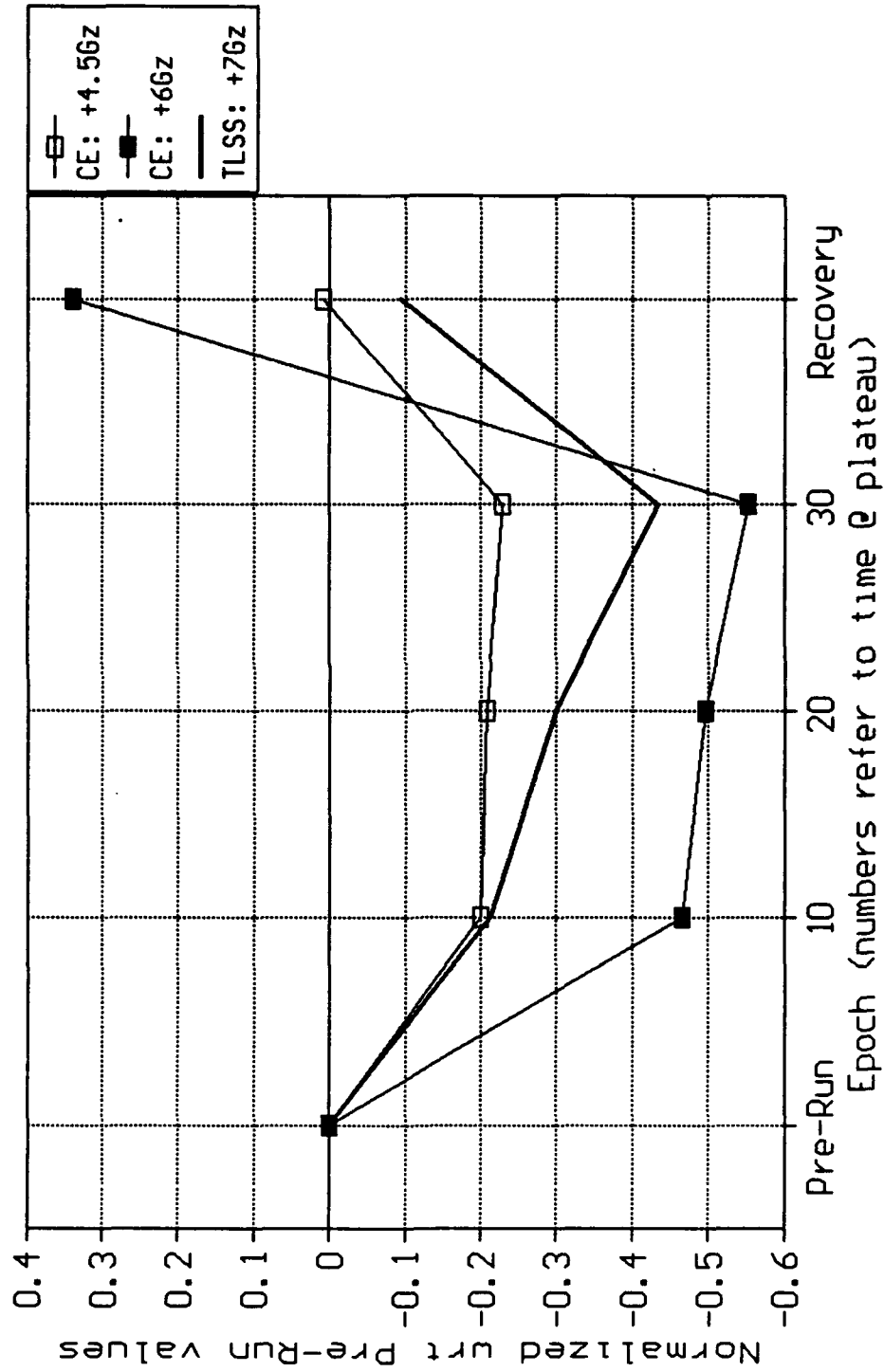


FIGURE 5. Change in Stroke Index for Subject S1 During +6g-Tolerance Runs

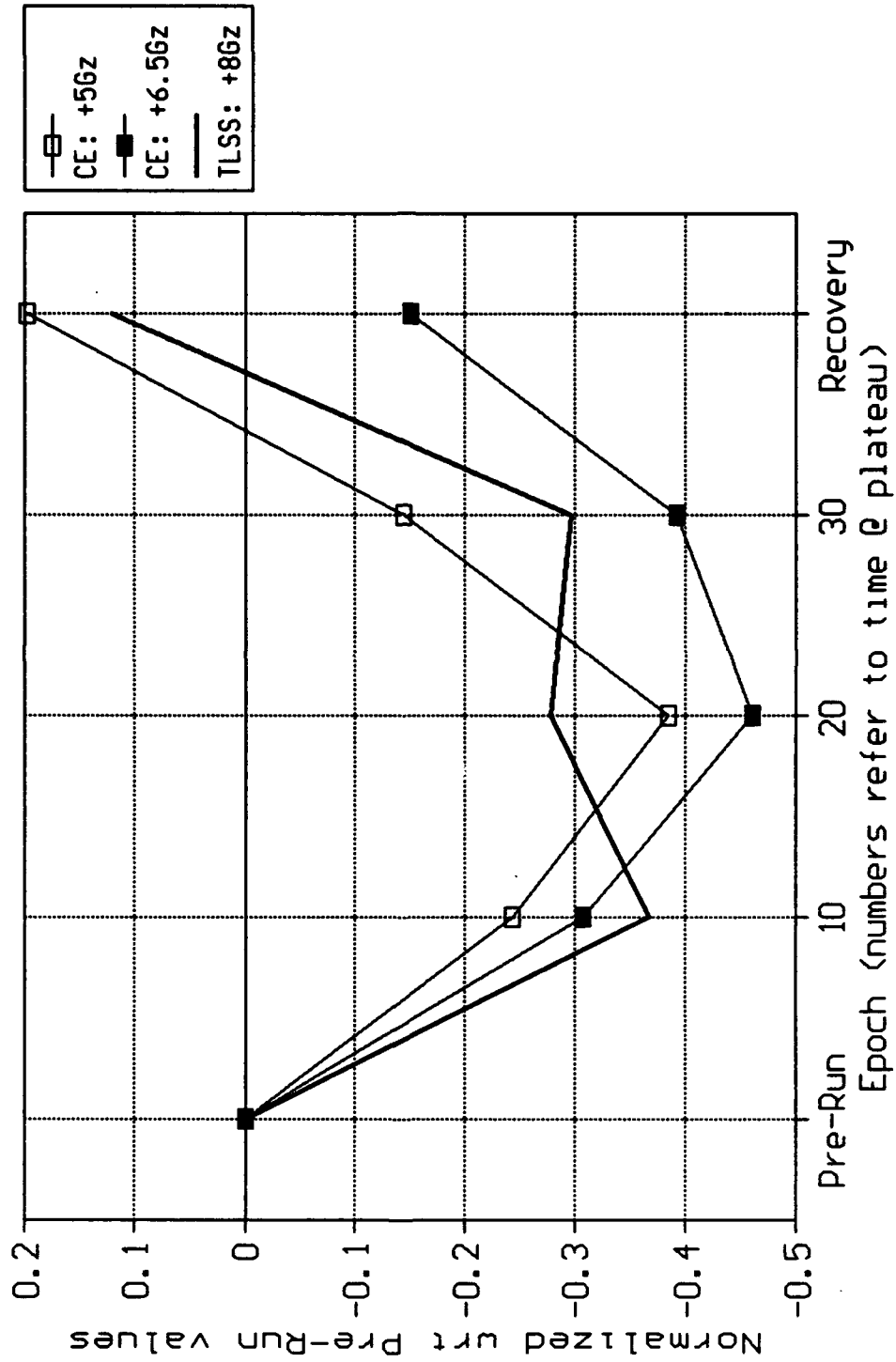


FIGURE 6. Change in Stroke Index for Subject S2 During +Gz-Tolerance Runs

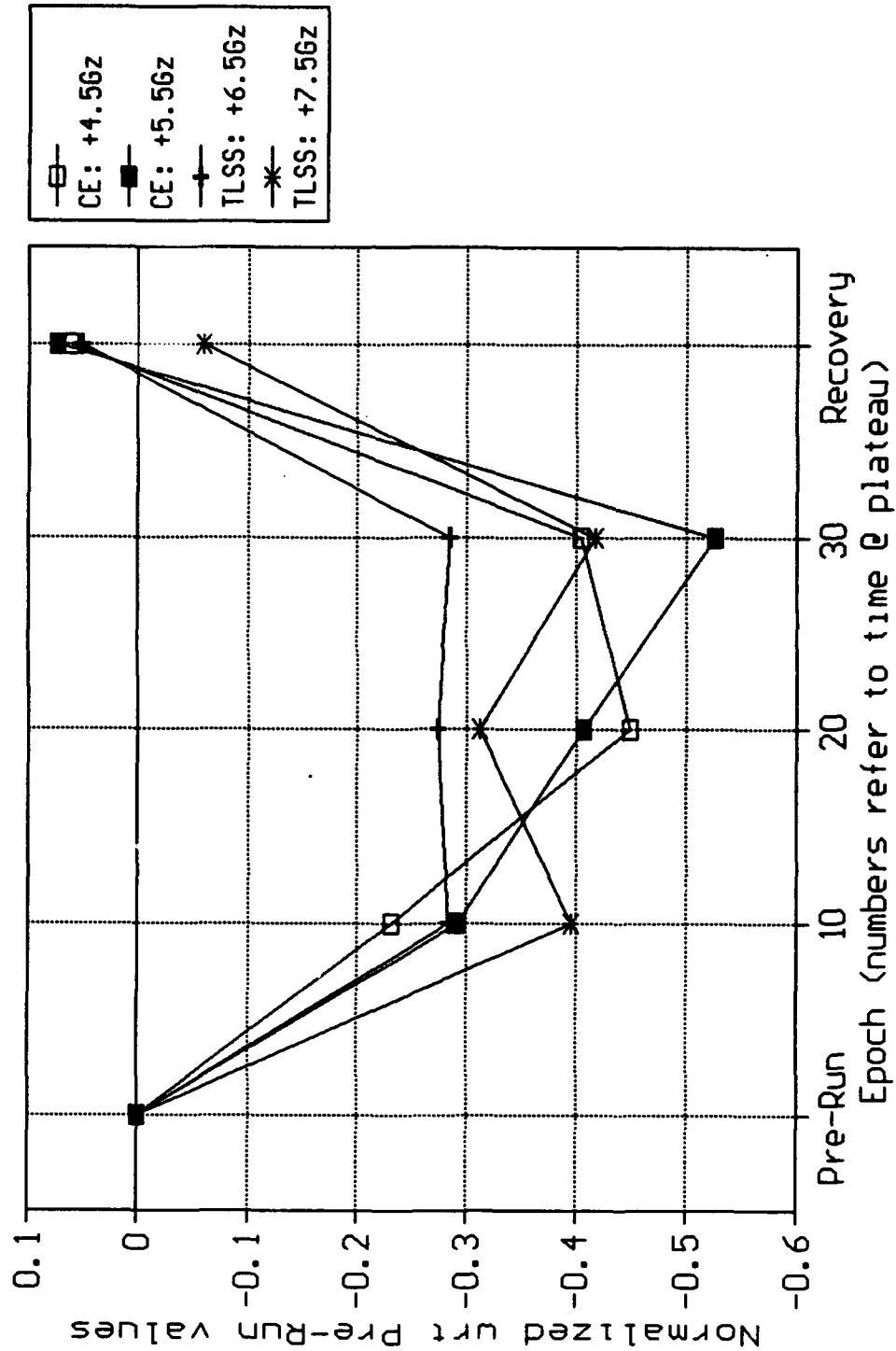


FIGURE 7. Change in Stroke Index for Subject S3 During +6Gz-Tolerance Runs

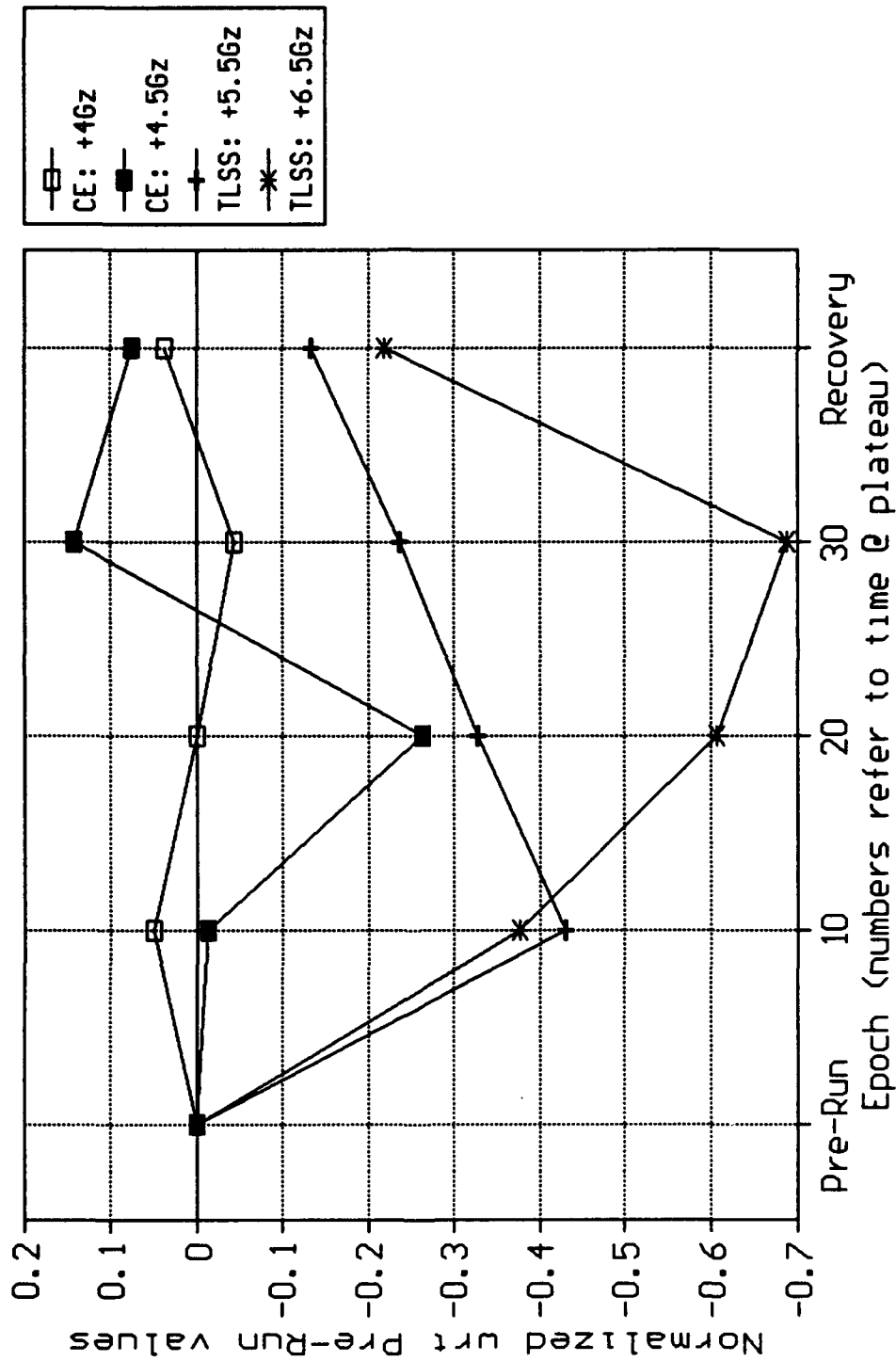


FIGURE 8. Change in Stroke Index for Subject S6 During +6Gz-Tolerance Runs

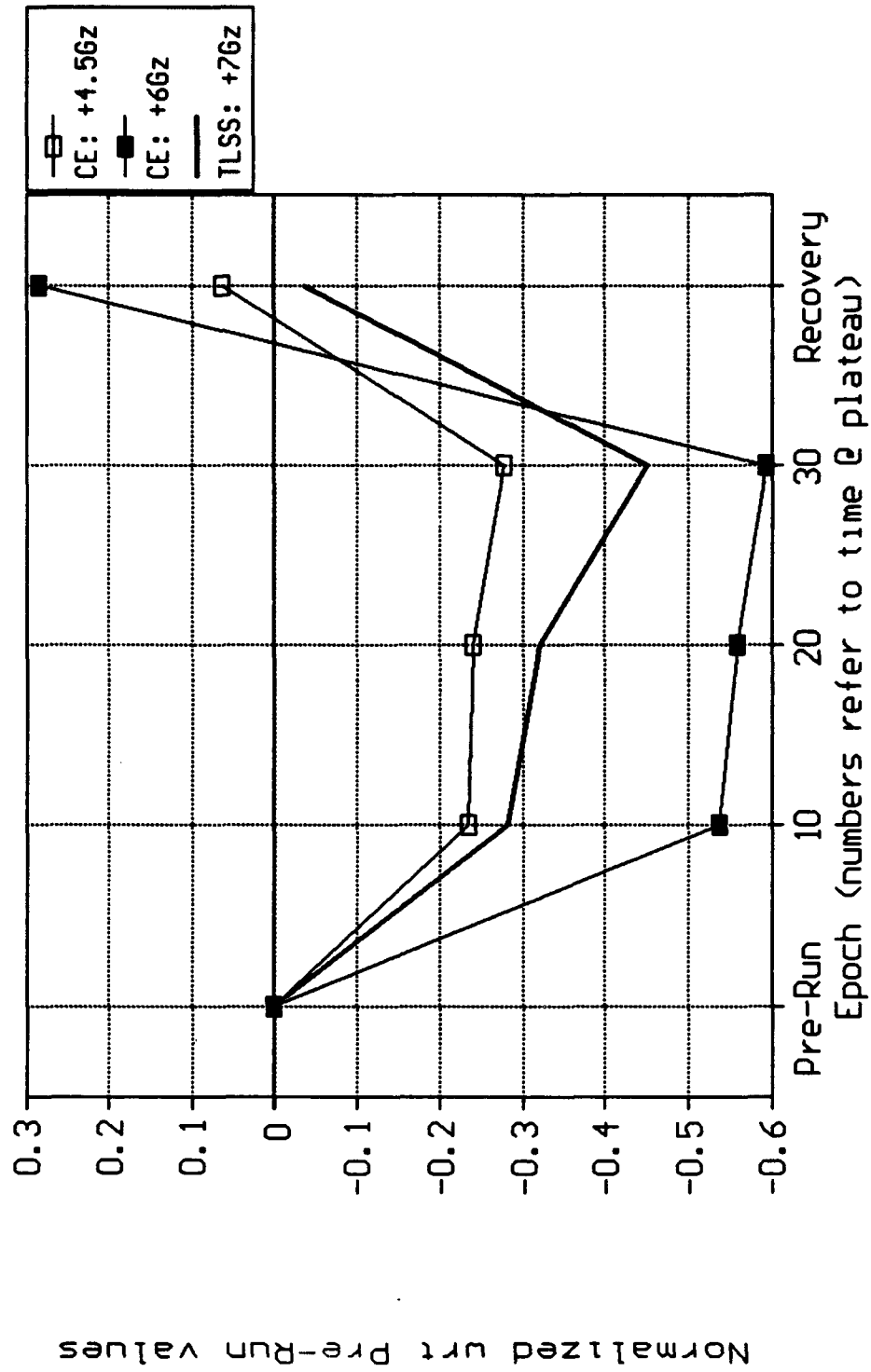


FIGURE 9. Change in Contractility Index  
for Subject S2: +Gz-Tolerance Runs

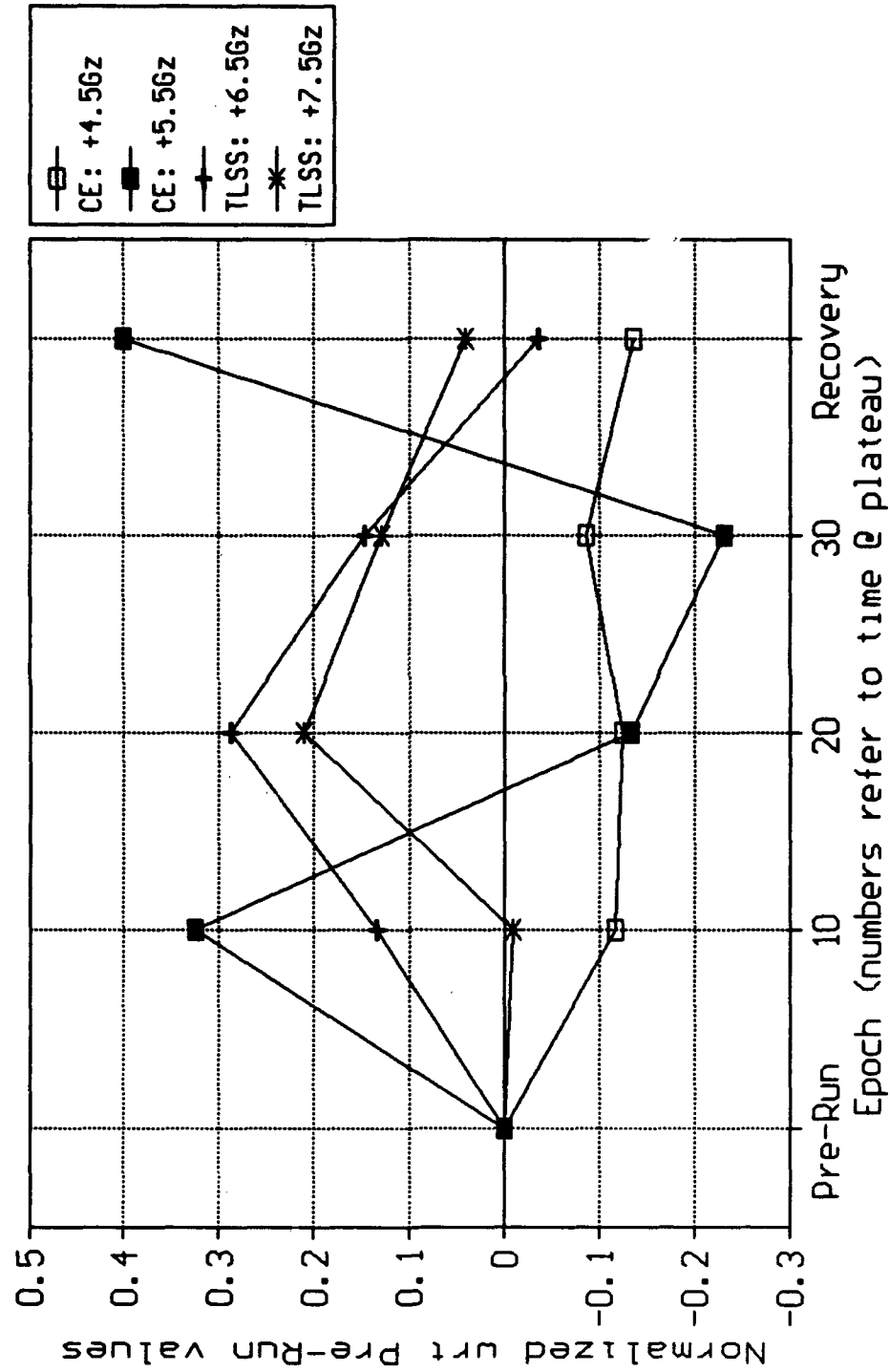


FIGURE 10. Contractility Index Change  
for Subject S3: +6z-Tolerance Runs

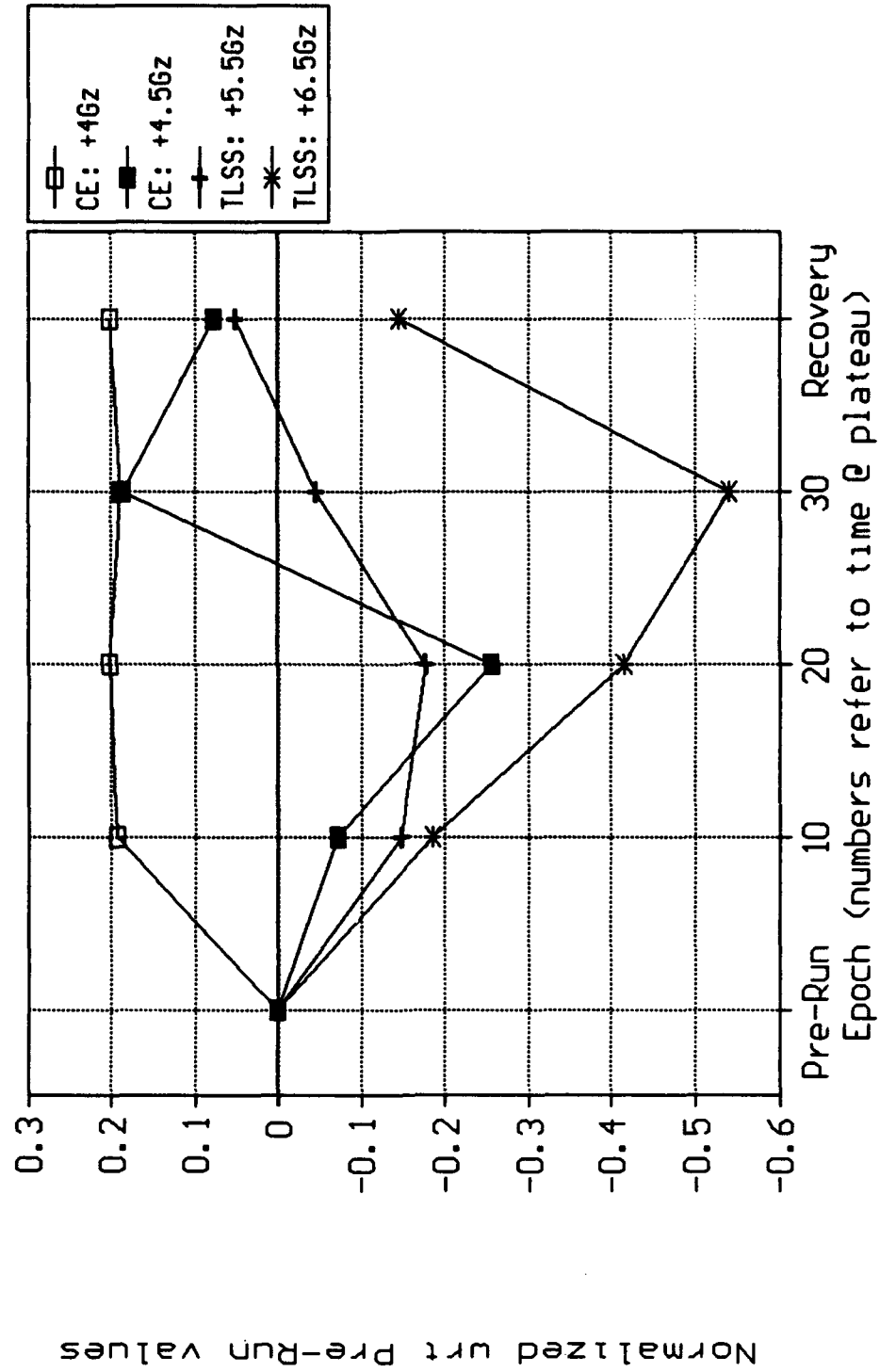


FIGURE 11. Contractility Index Change  
for Subject S6: +Gz-Tolerance Runs

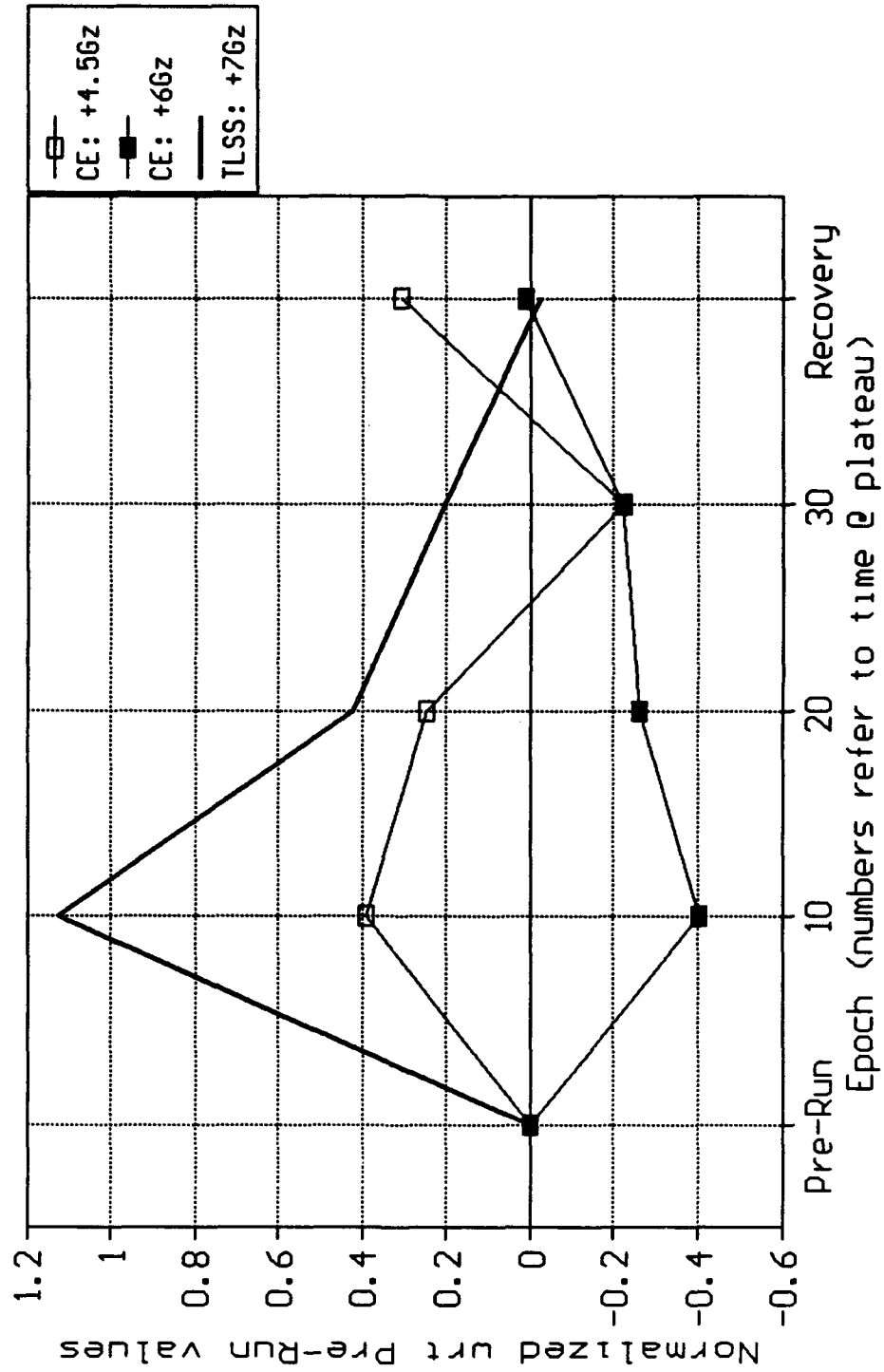


FIGURE 12. Change in Heart Rate for Subject S1 During +6g-Tolerance Runs

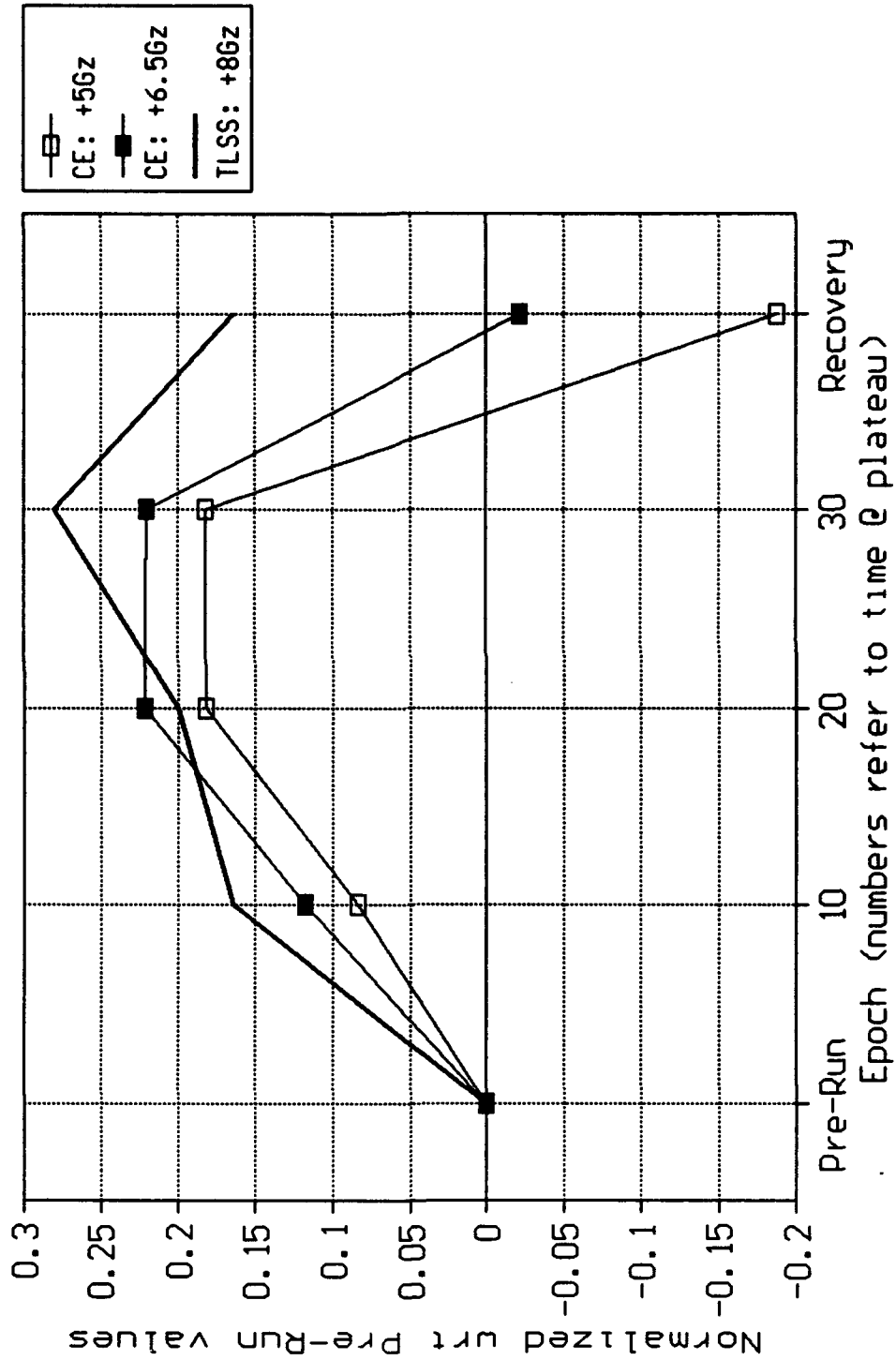


FIGURE 13. Change in Heart Rate for  
Subject S2 During +Gz-Tolerance Runs

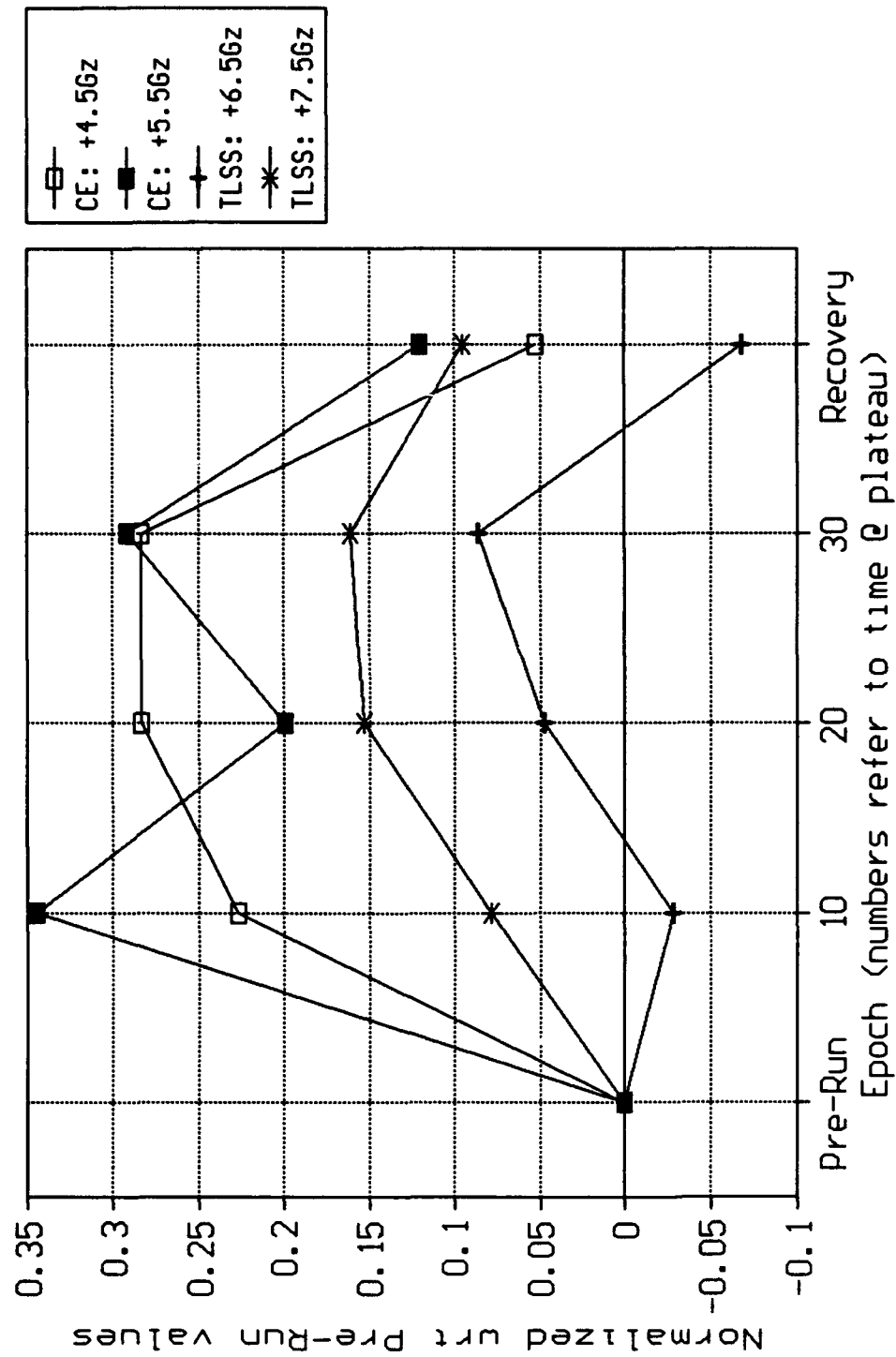


FIGURE 14. Change in Heart Rate for  
Subject S3 During +6z-Tolerance Runs

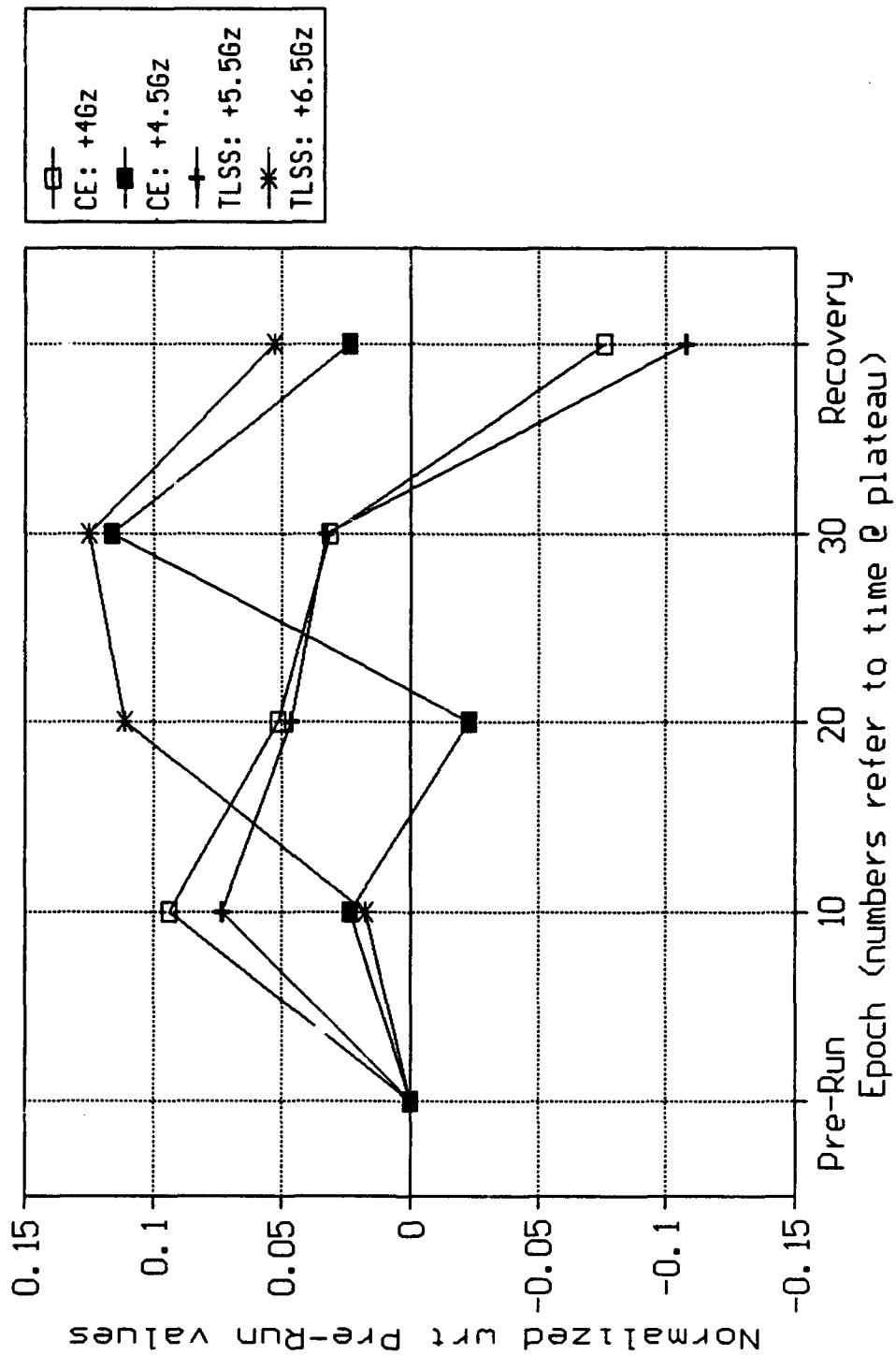


FIGURE 15. Change in Heart Rate for Subject S6 During +6Gz-Tolerance Runs

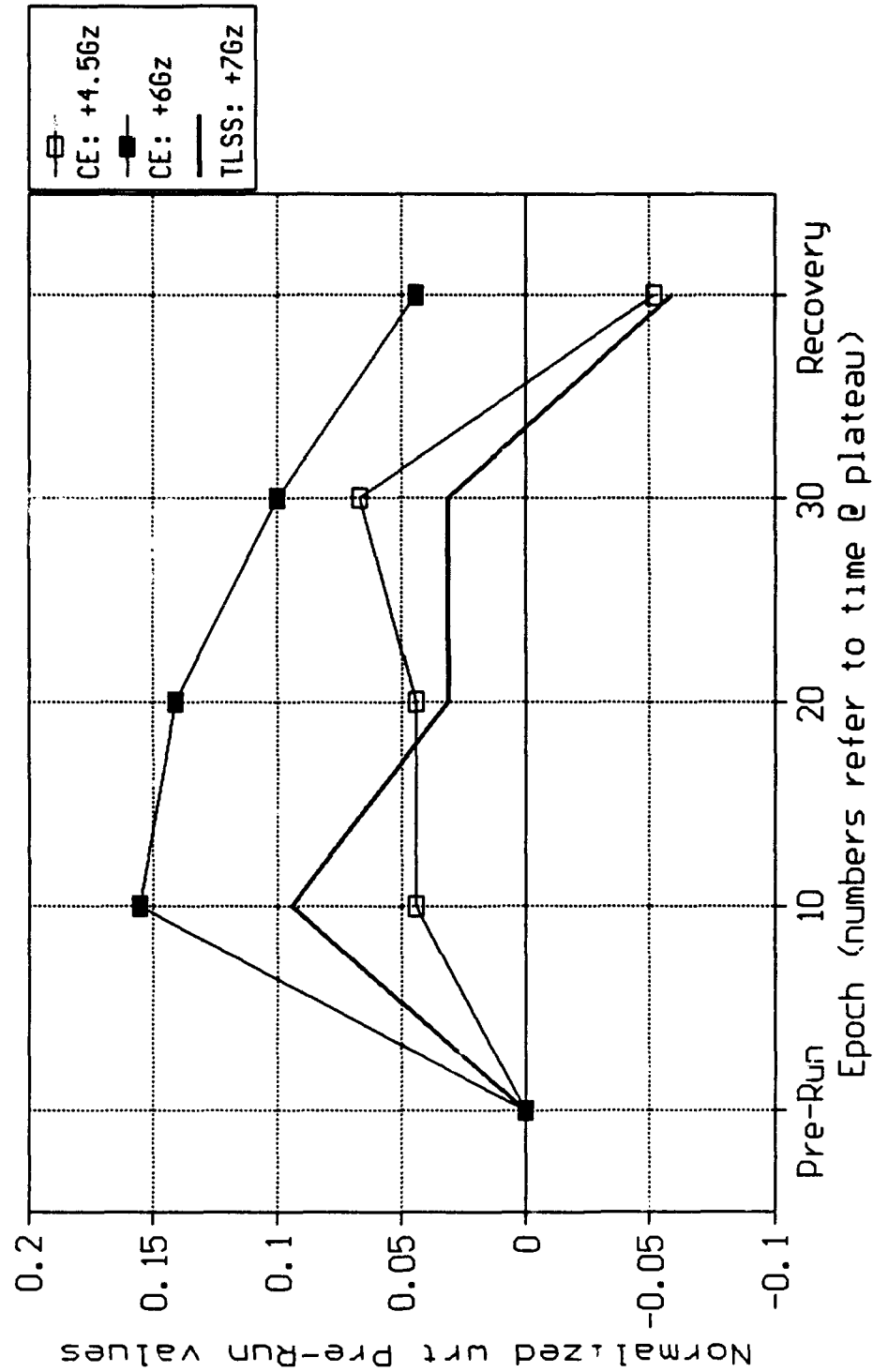


FIGURE 16: Change in Pulse Wave Delay  
for Subject S2: +6Gz-Tolerance Runs

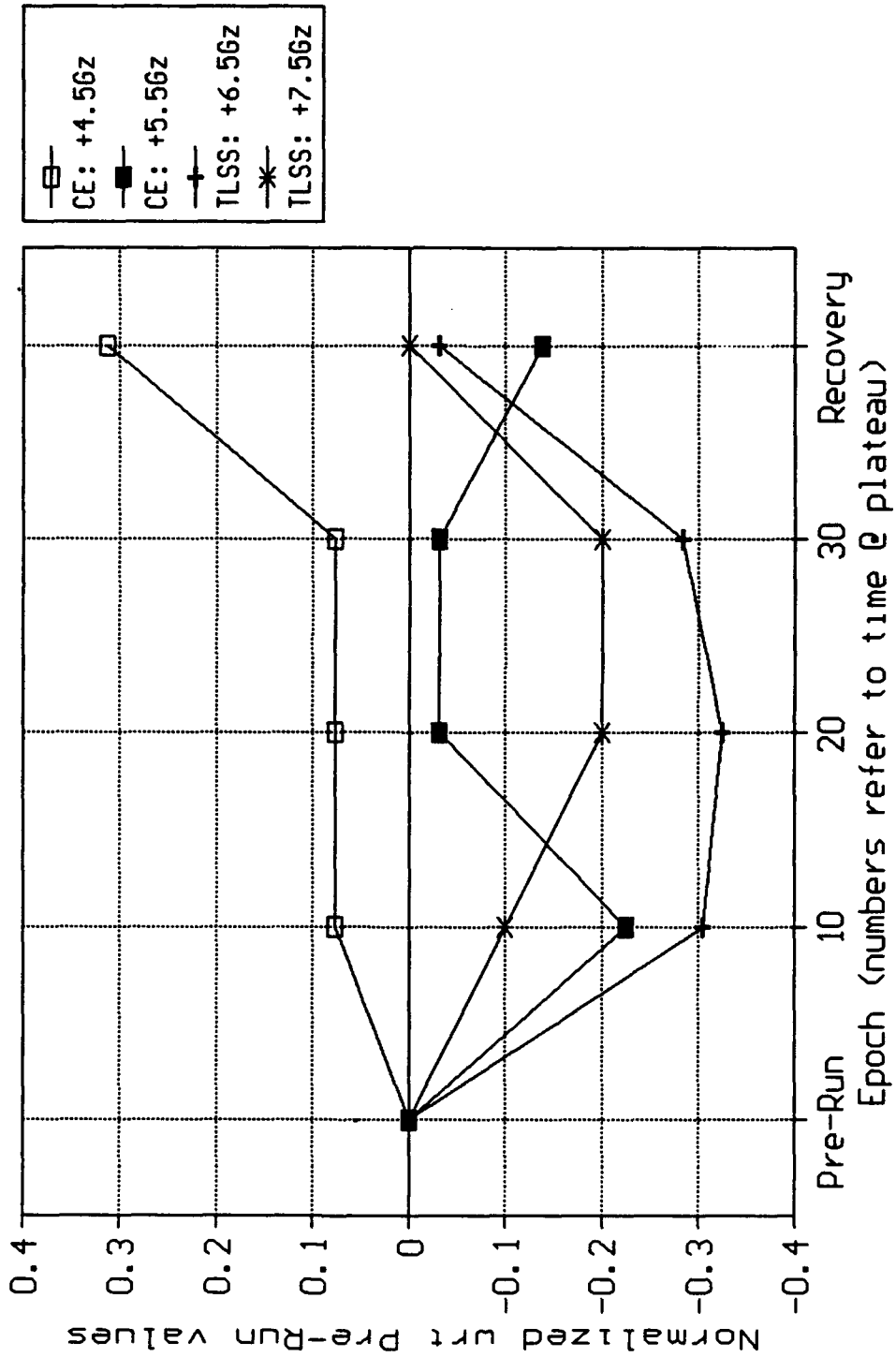


FIGURE 17. Change in Pulse Wave Delay  
for Subject S3: +Gz-Tolerance Runs

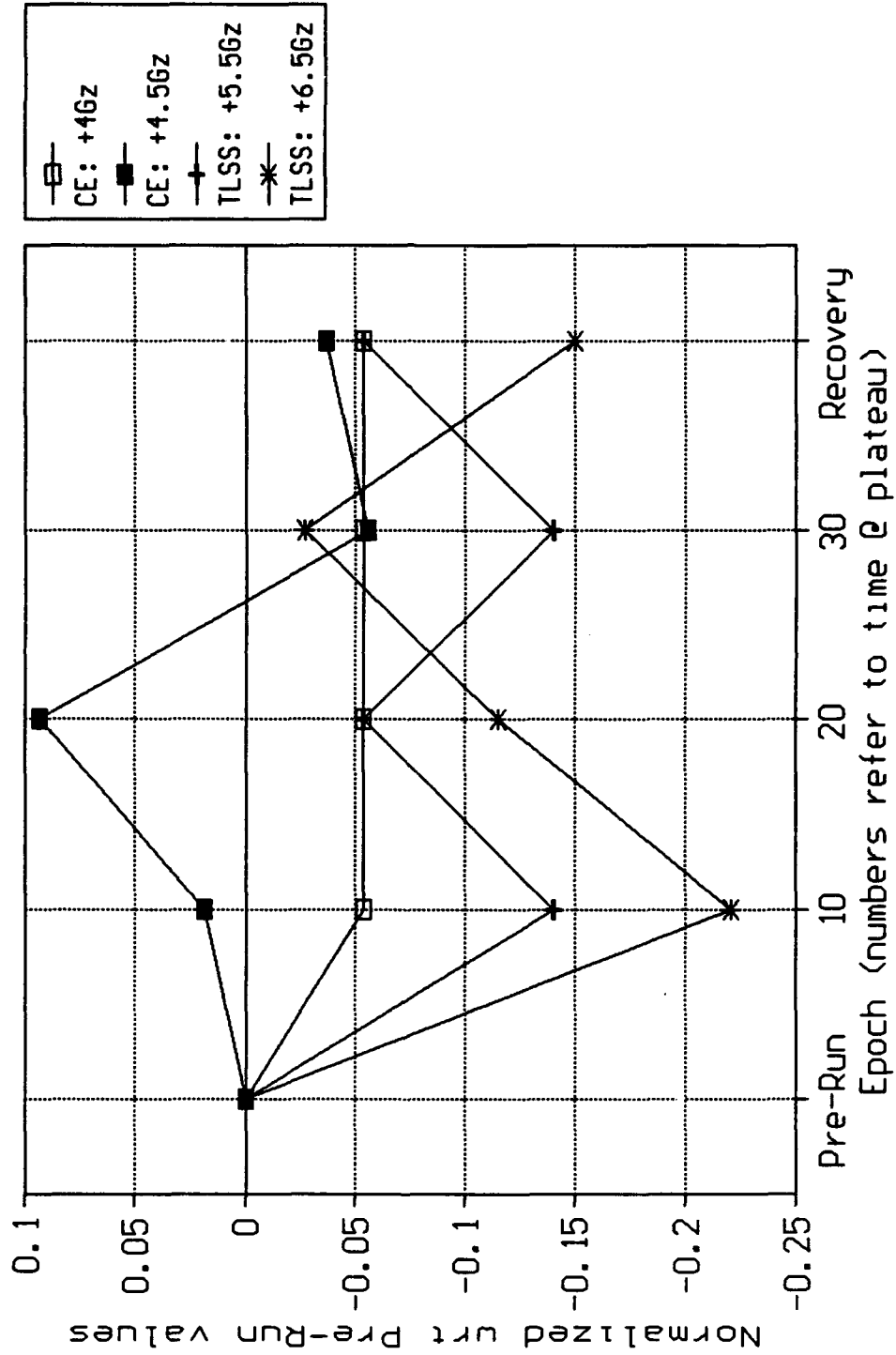


FIGURE 18. Change in Pulse Wave Delay  
for Subject S6: +Gz-Tolerance Runs

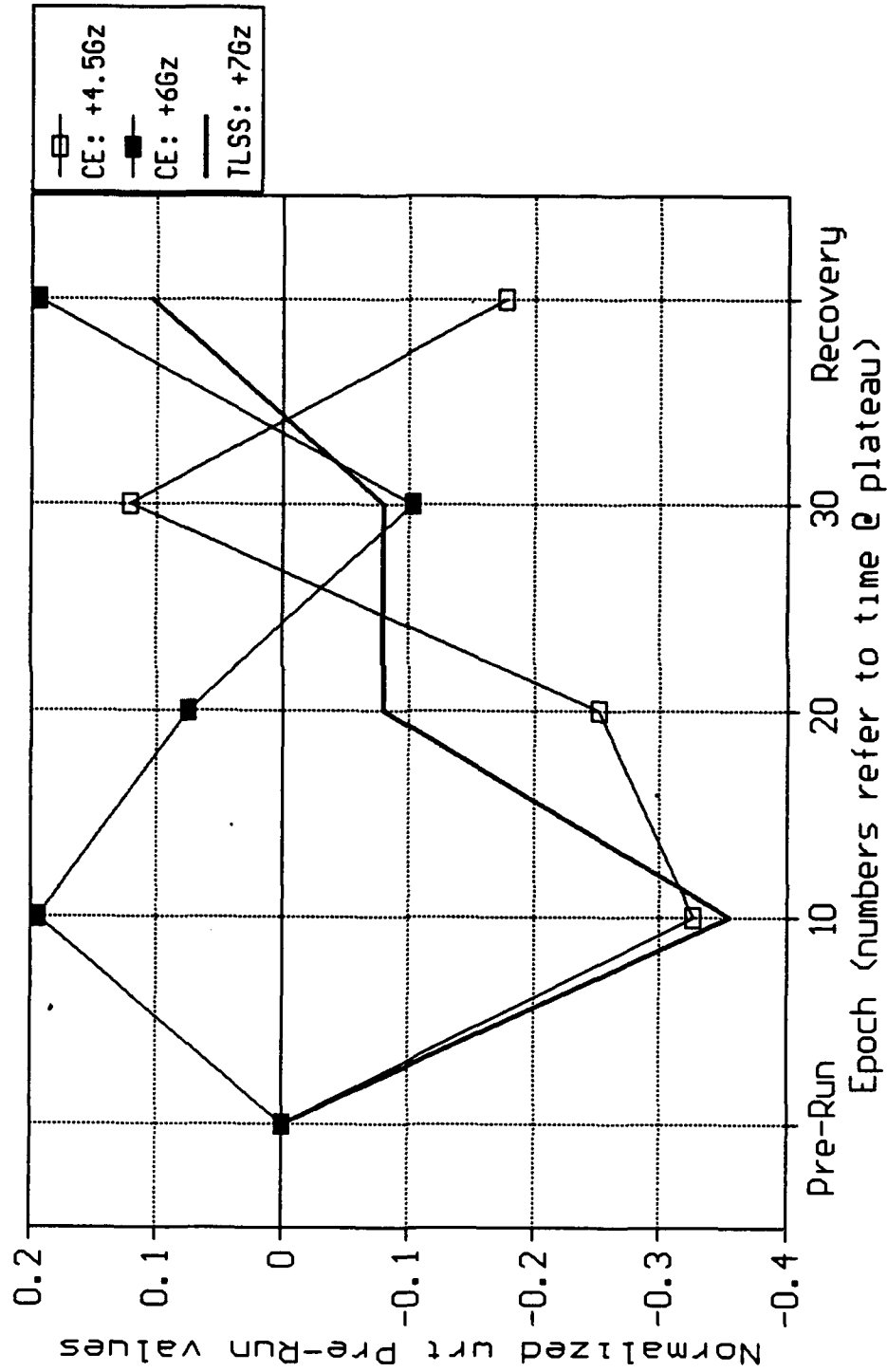


FIGURE 19. Mean Change in Cardiac Index  
Comparison Between TLSS and COMBAT EDGE

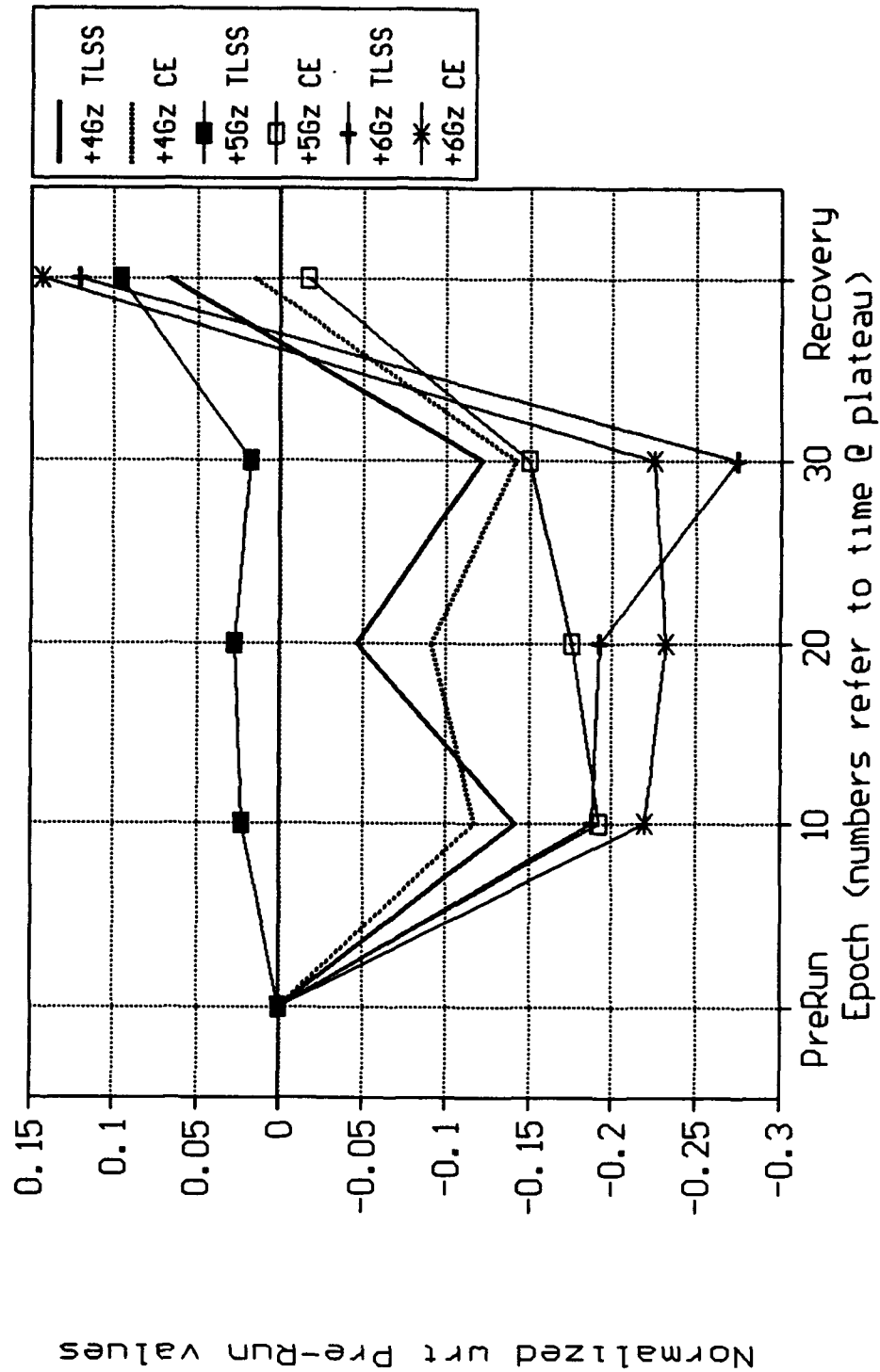


FIGURE 20. Mean Cardiac Output:  
Comparison Between TLSS and COMBAT EDGE

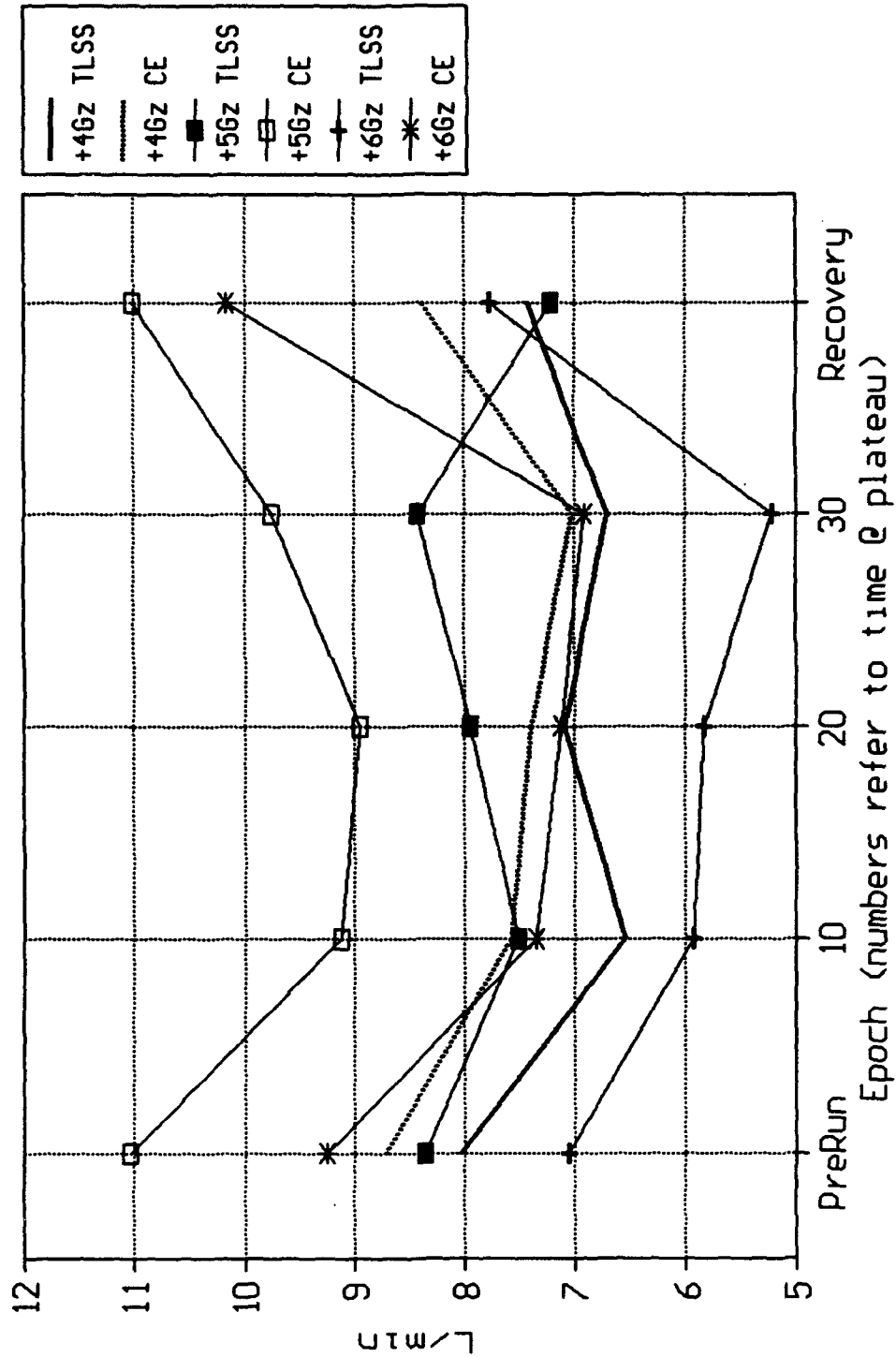


FIGURE 21. Mean Change in Stroke Index:  
Comparison Between TLSS and COMBAT EDGE

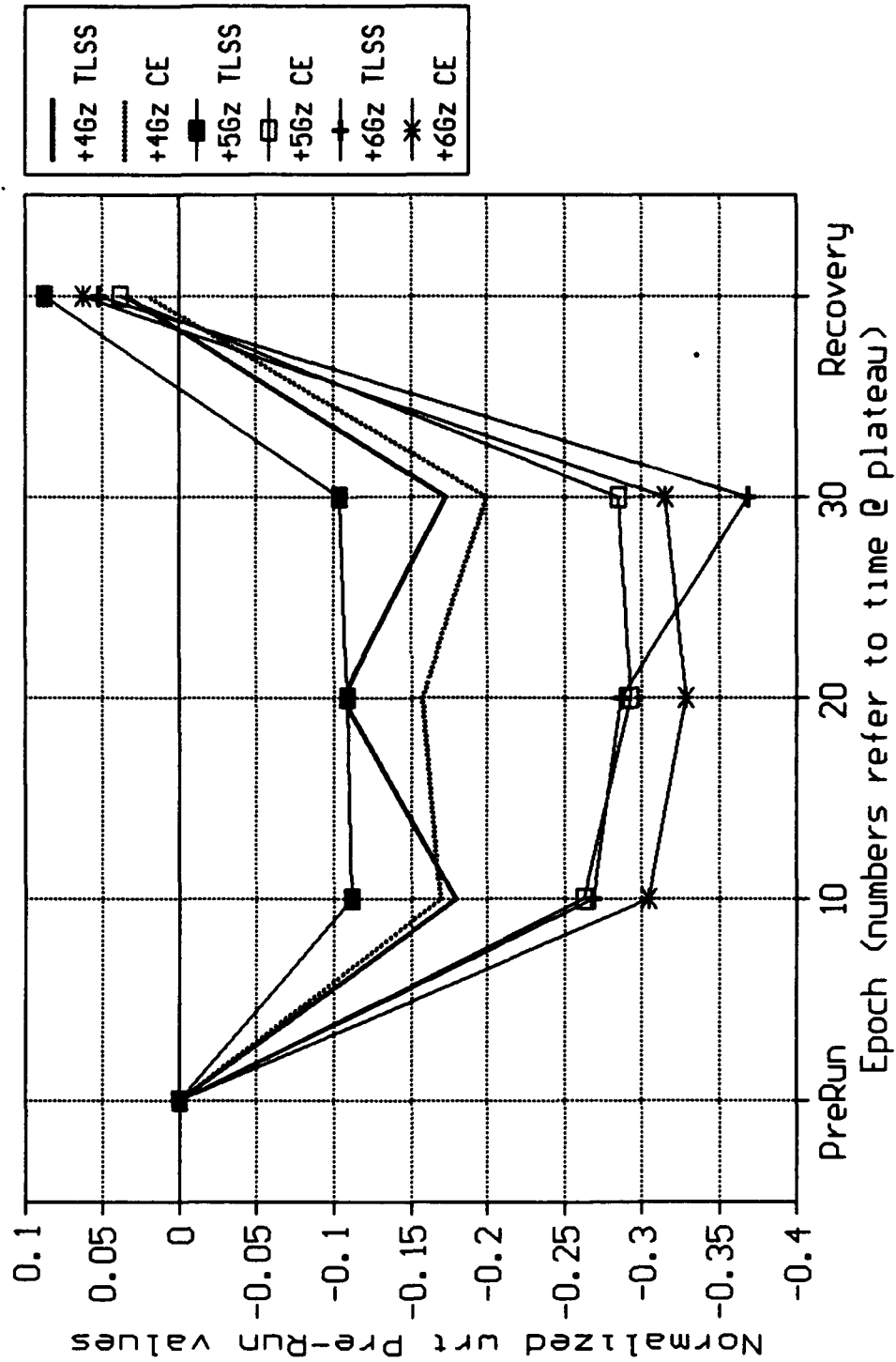


FIGURE 22. Mean Stroke Volume:  
Comparison Between TLSS and COMBAT EDGE

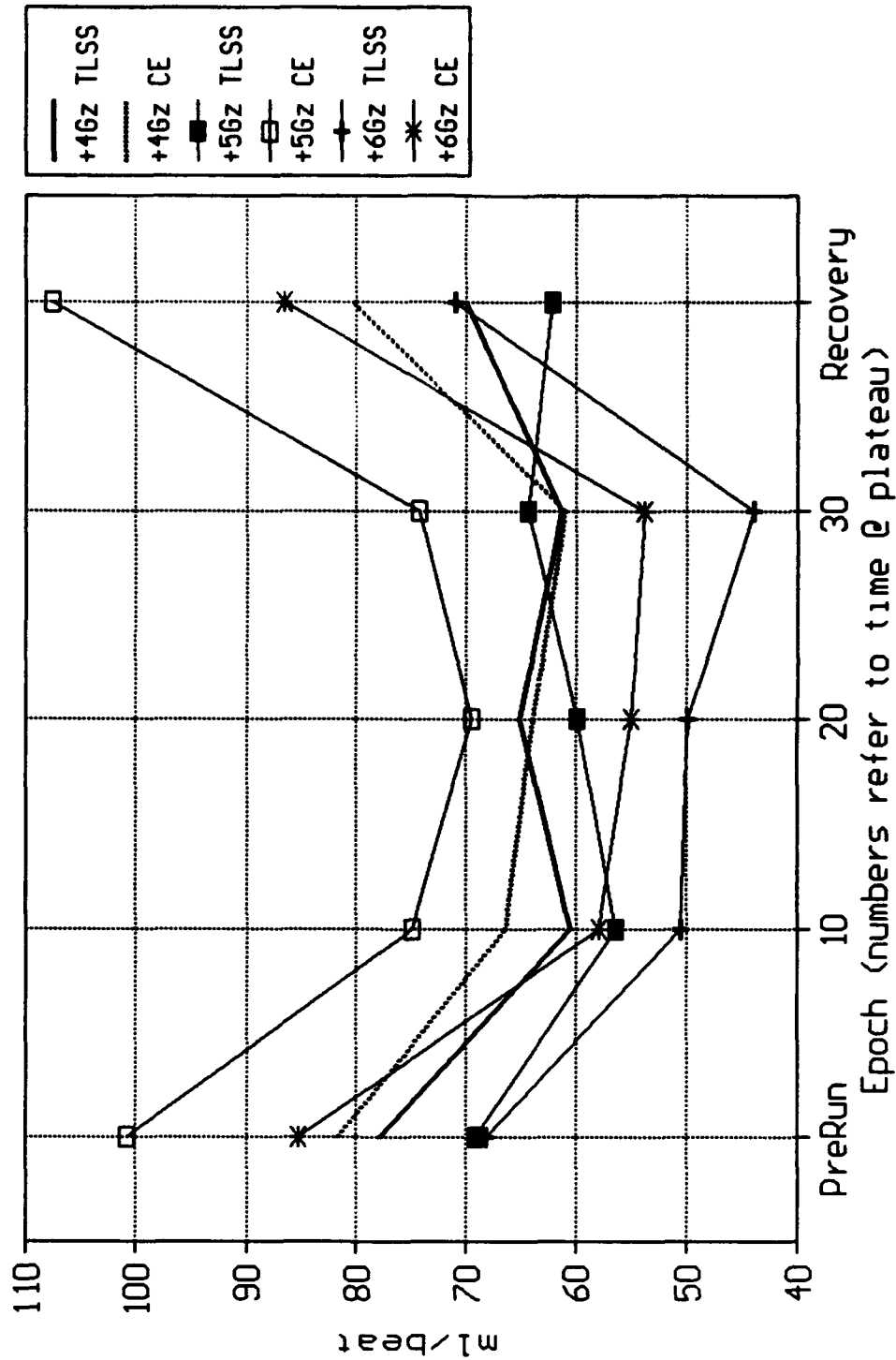


FIGURE 23. Mean Change in Contractility  
Index: Comparison Between TLSS and CE

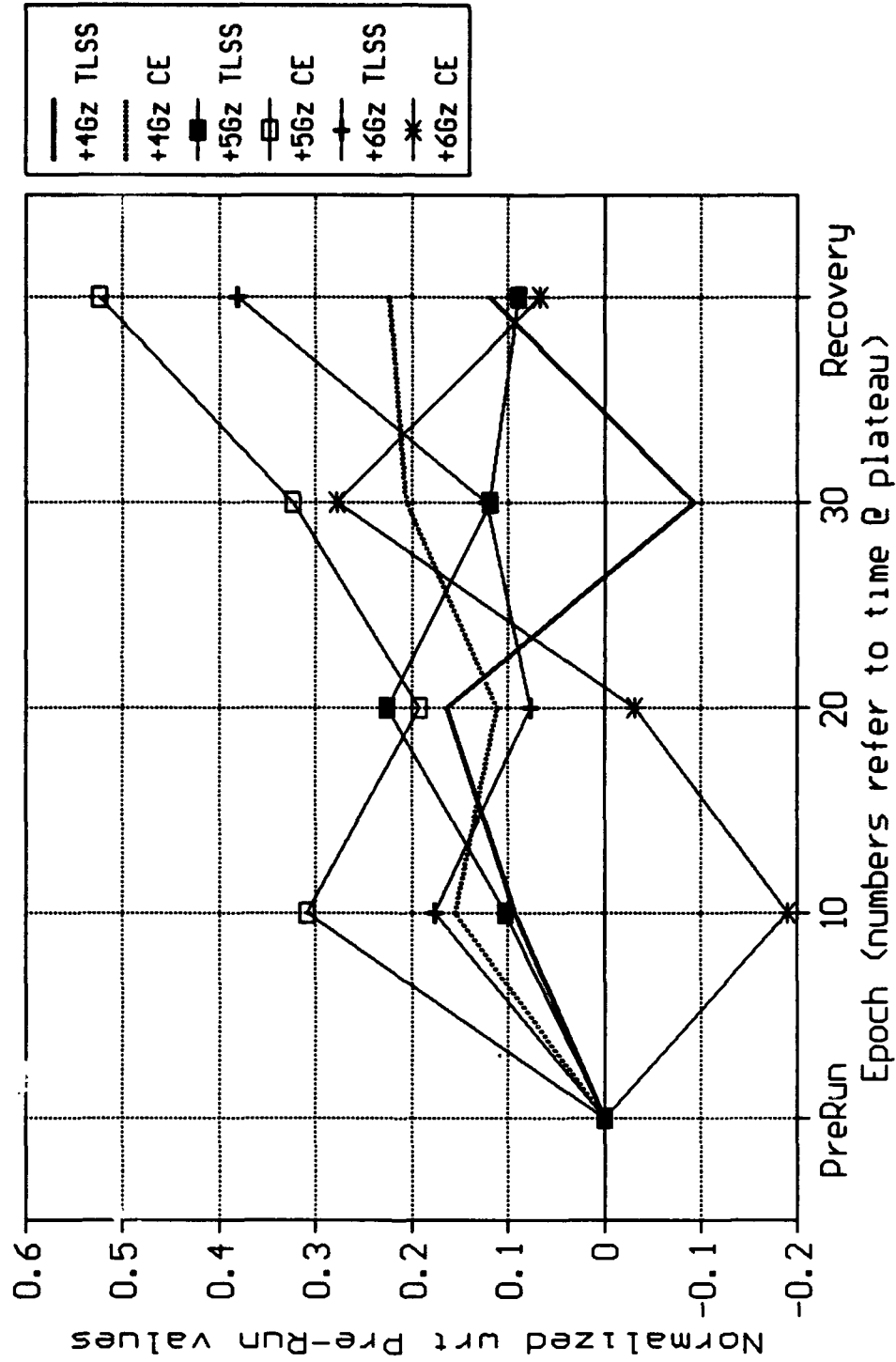


FIGURE 24. Mean Cardiac Contractility:  
Comparison Between TLSS and COMBAT EDGE

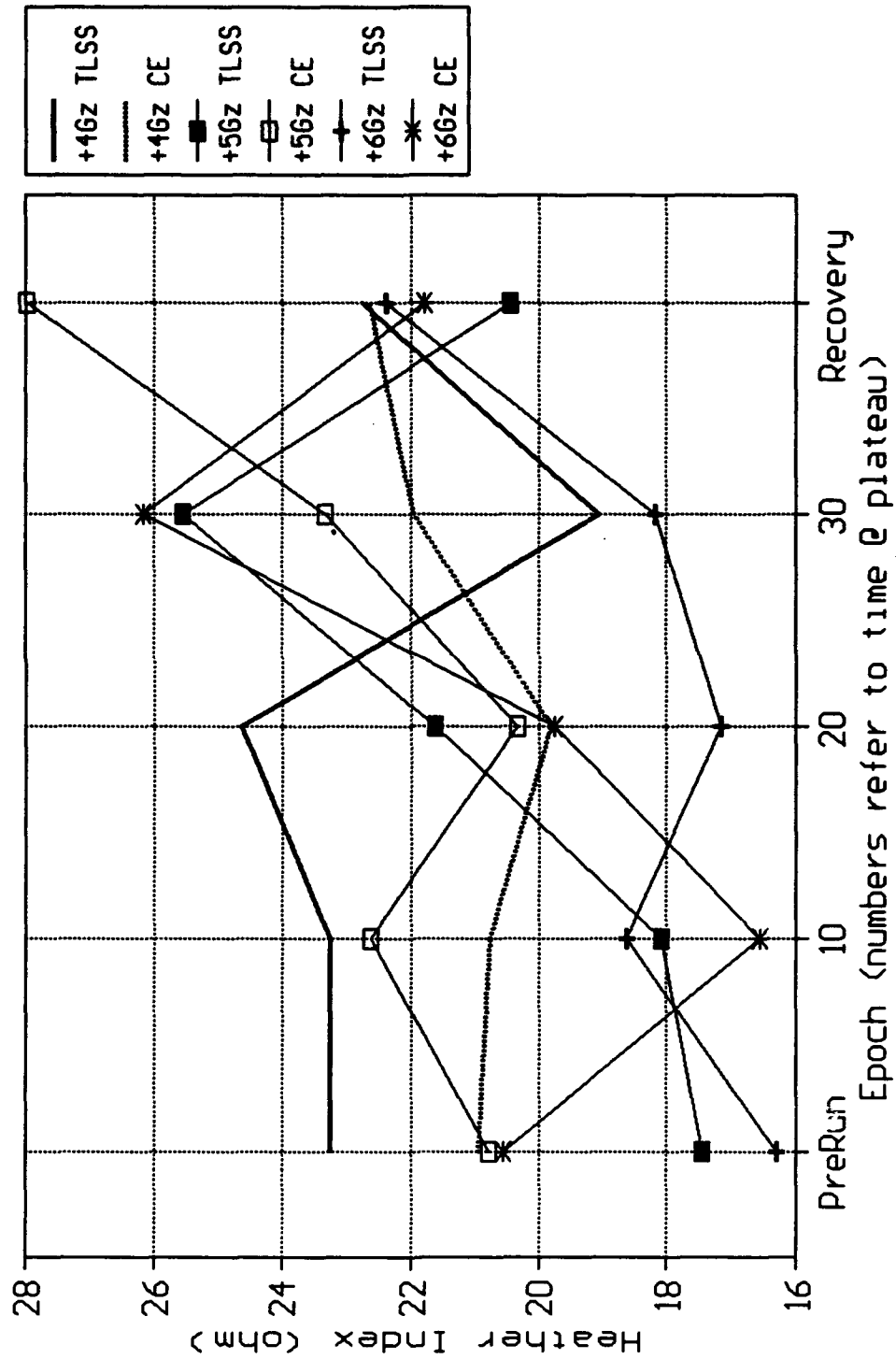


FIGURE 25. Mean Change in Heart Rate:  
Comparison Between TLSS and COMBAT EDGE

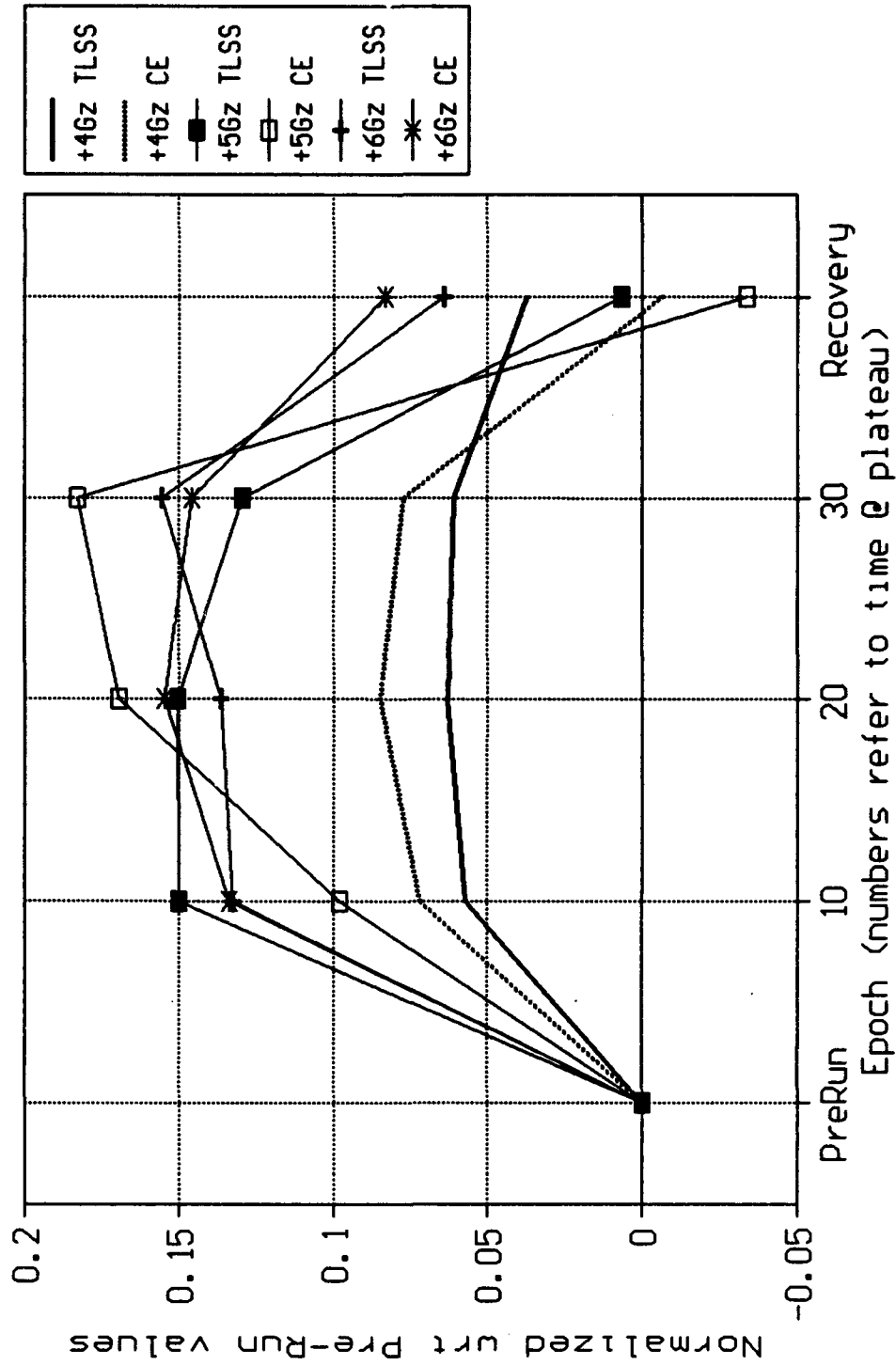


FIGURE 26. Mean Heart Rate:  
Comparison Between TLSS and COMBAT EDGE

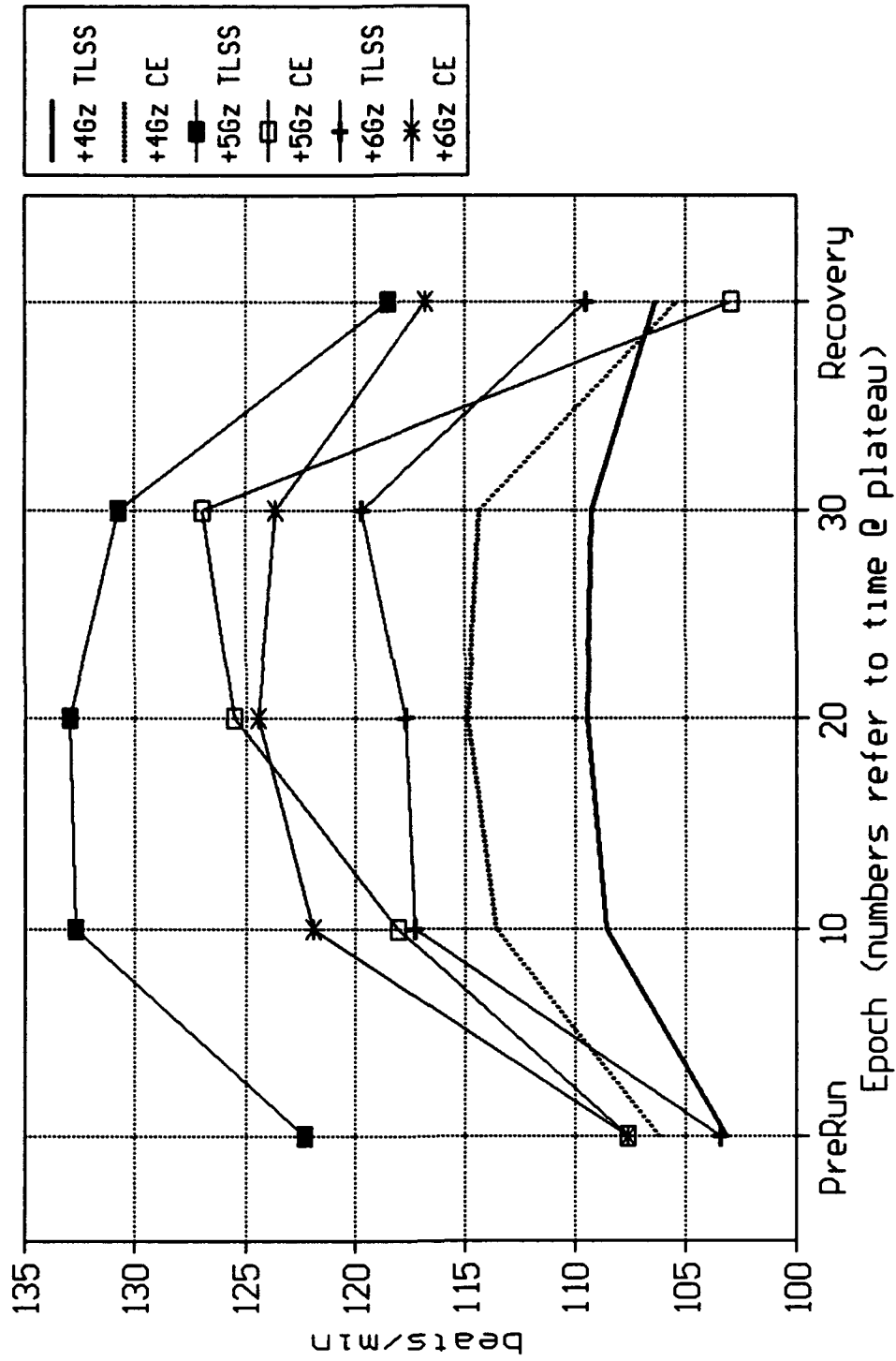


FIGURE 27. Mean Change in Pulse Wave Delay: Comparison Between TLSS and CE

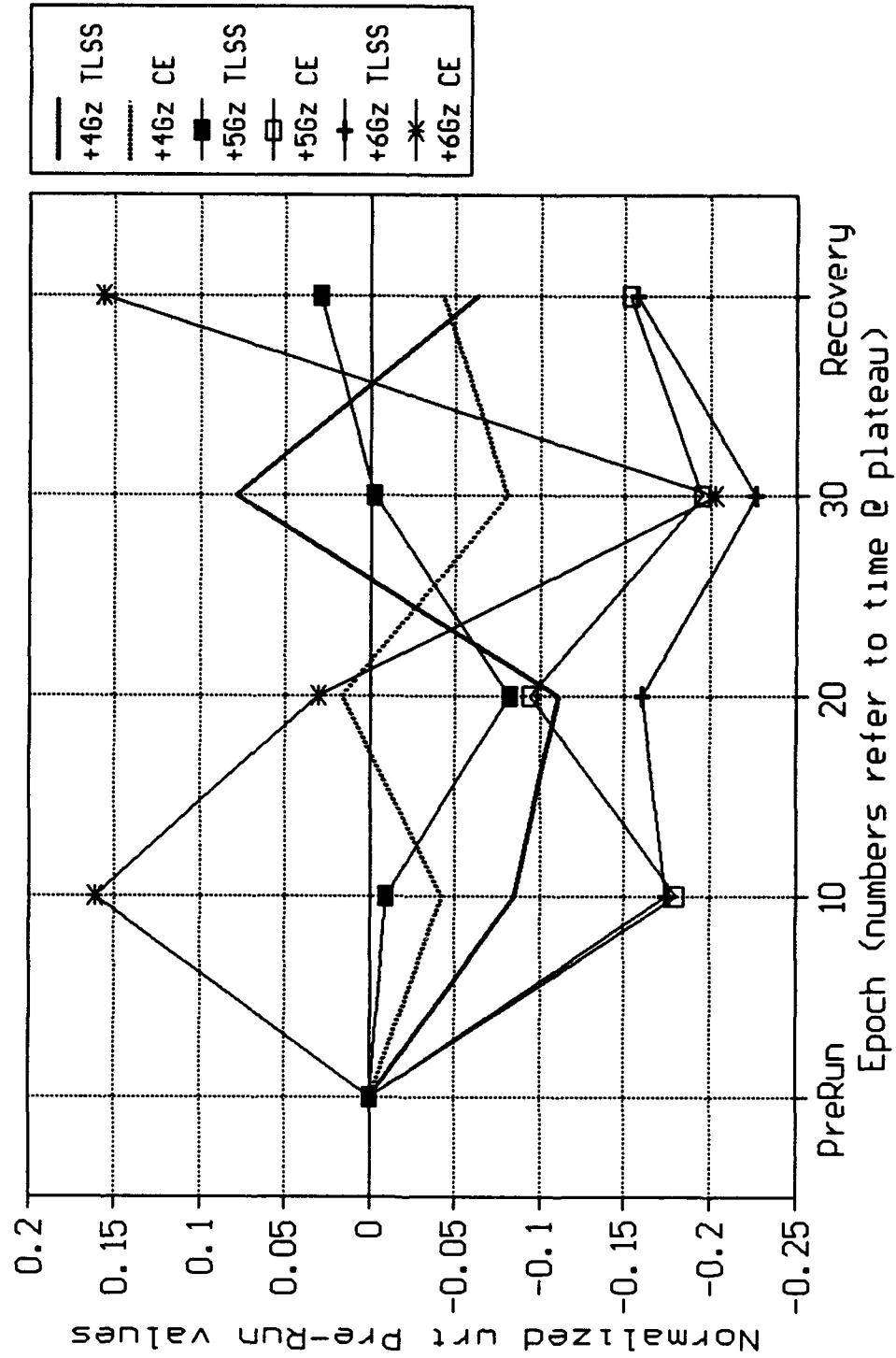


FIGURE 28. Mean Pulse Wave Delay:  
Comparison Between TLSS and COMBAT EDGE

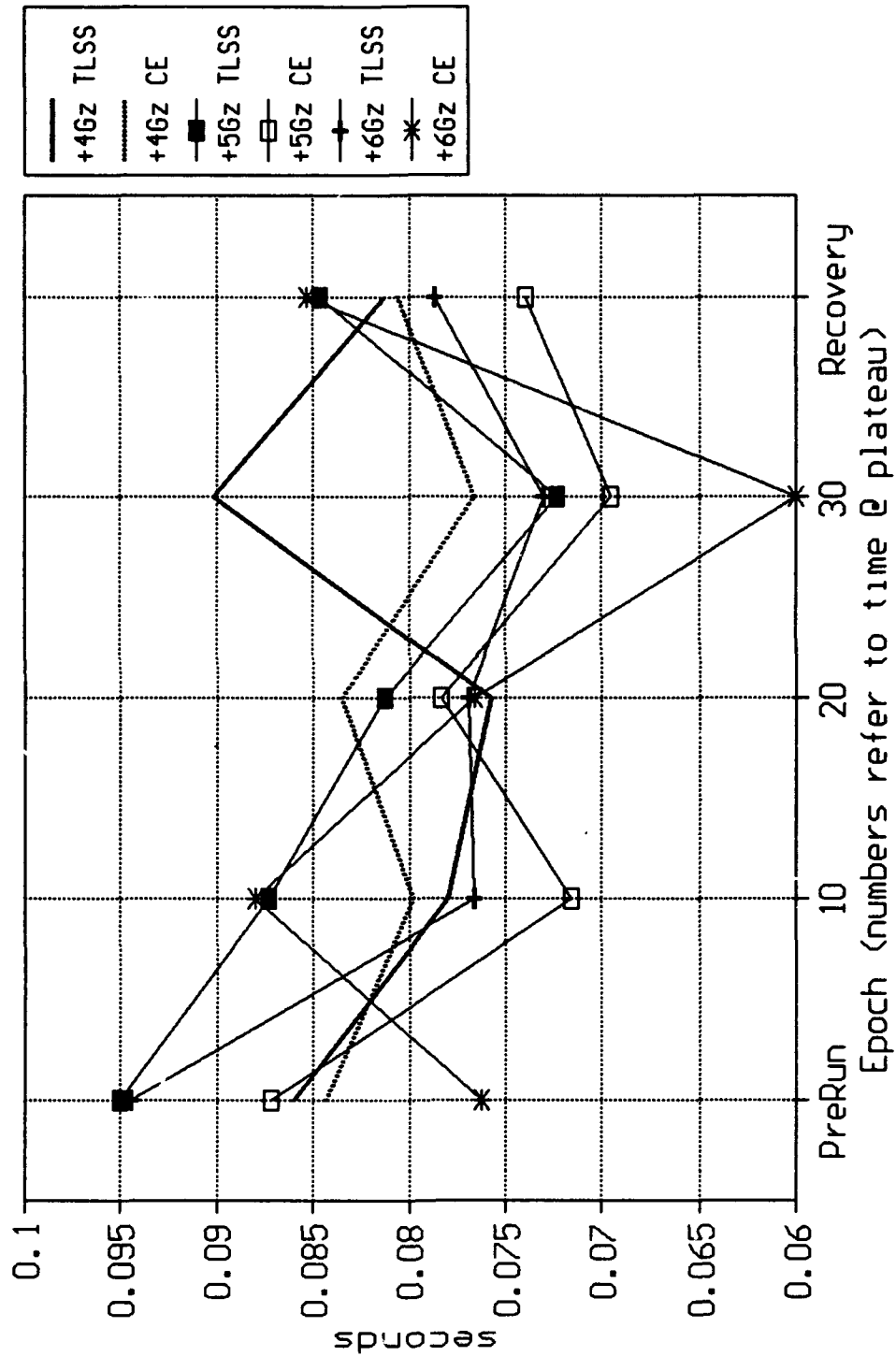


FIGURE 29. Mean Change in Cardiac Index  
for Subjects Wearing TLSS

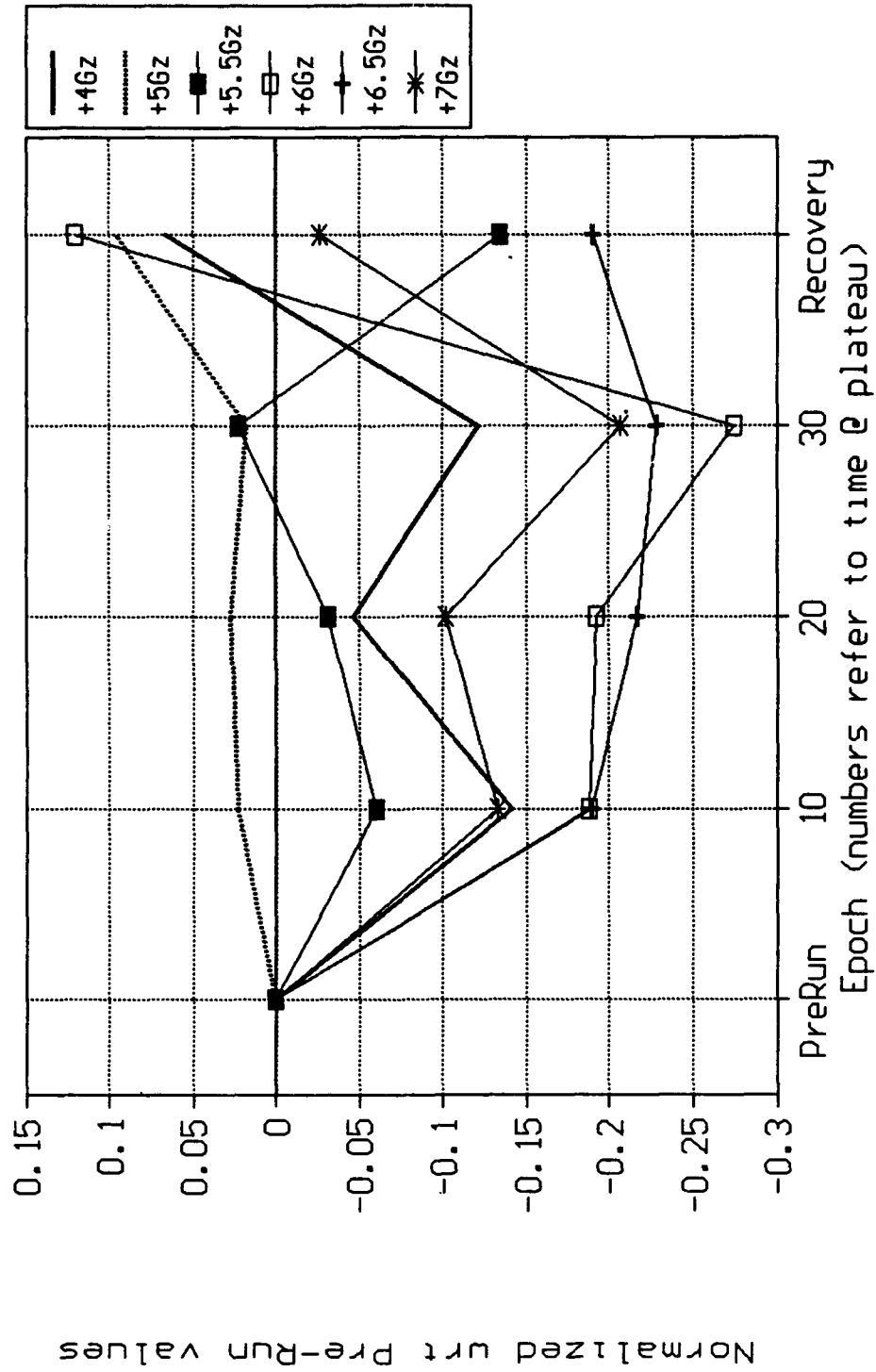


FIGURE 30. Mean Cardiac Output  
for Subjects Wearing TLSS

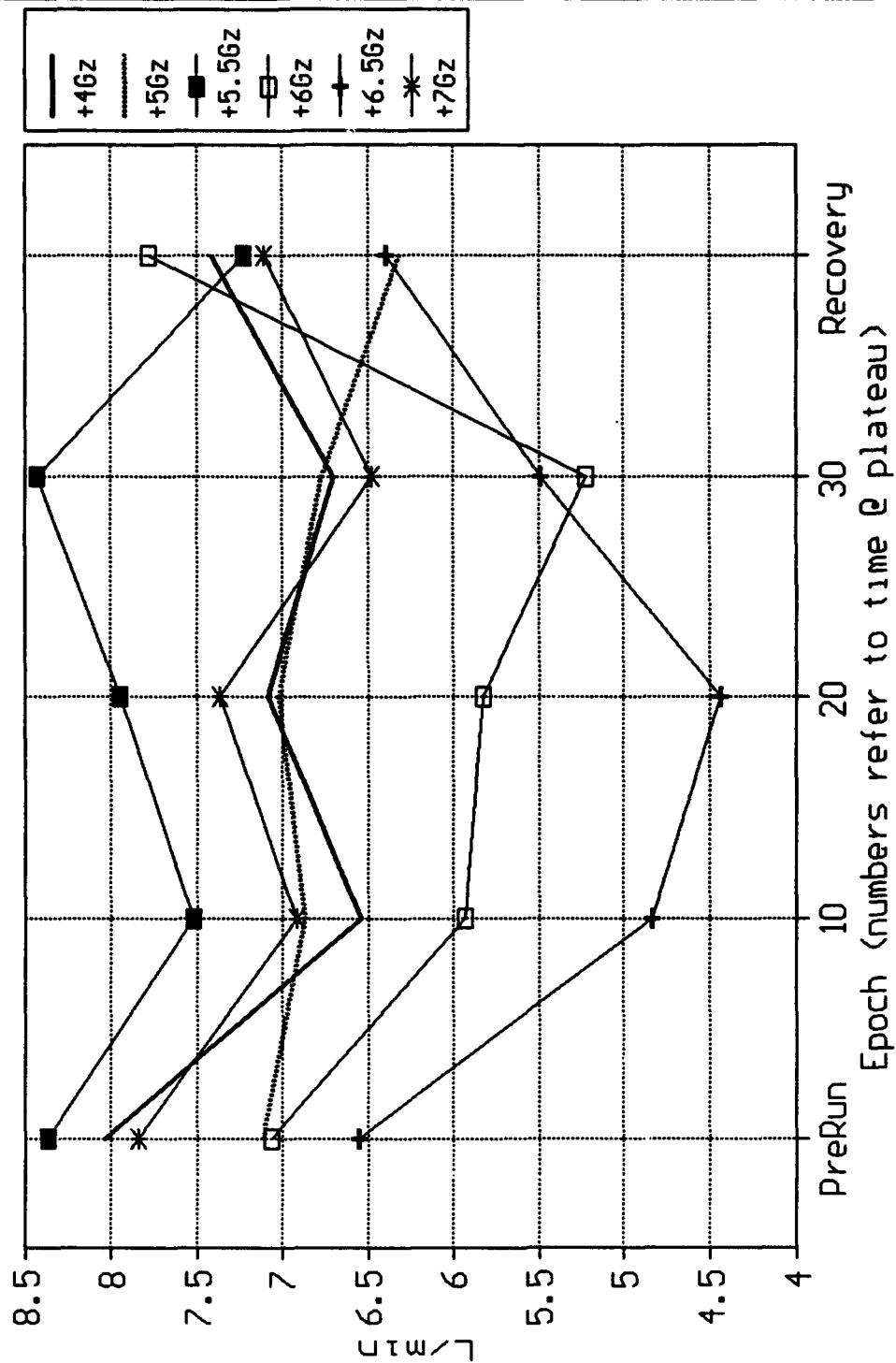


FIGURE 31. Mean Change in Stroke Index  
for Subjects Wearing TLSS

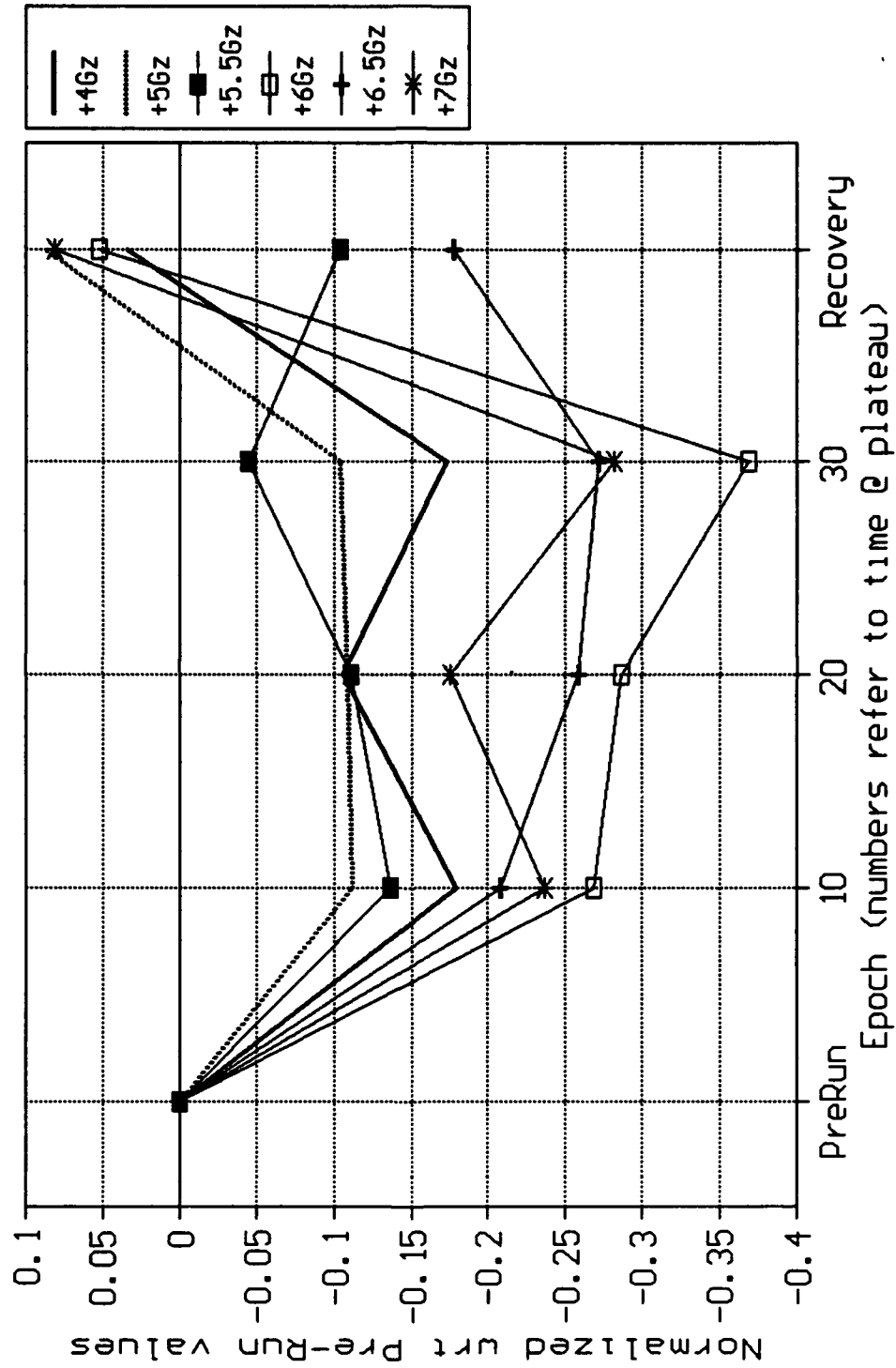


FIGURE 32. Mean Stroke Volume  
for Subjects Wearing TLSS

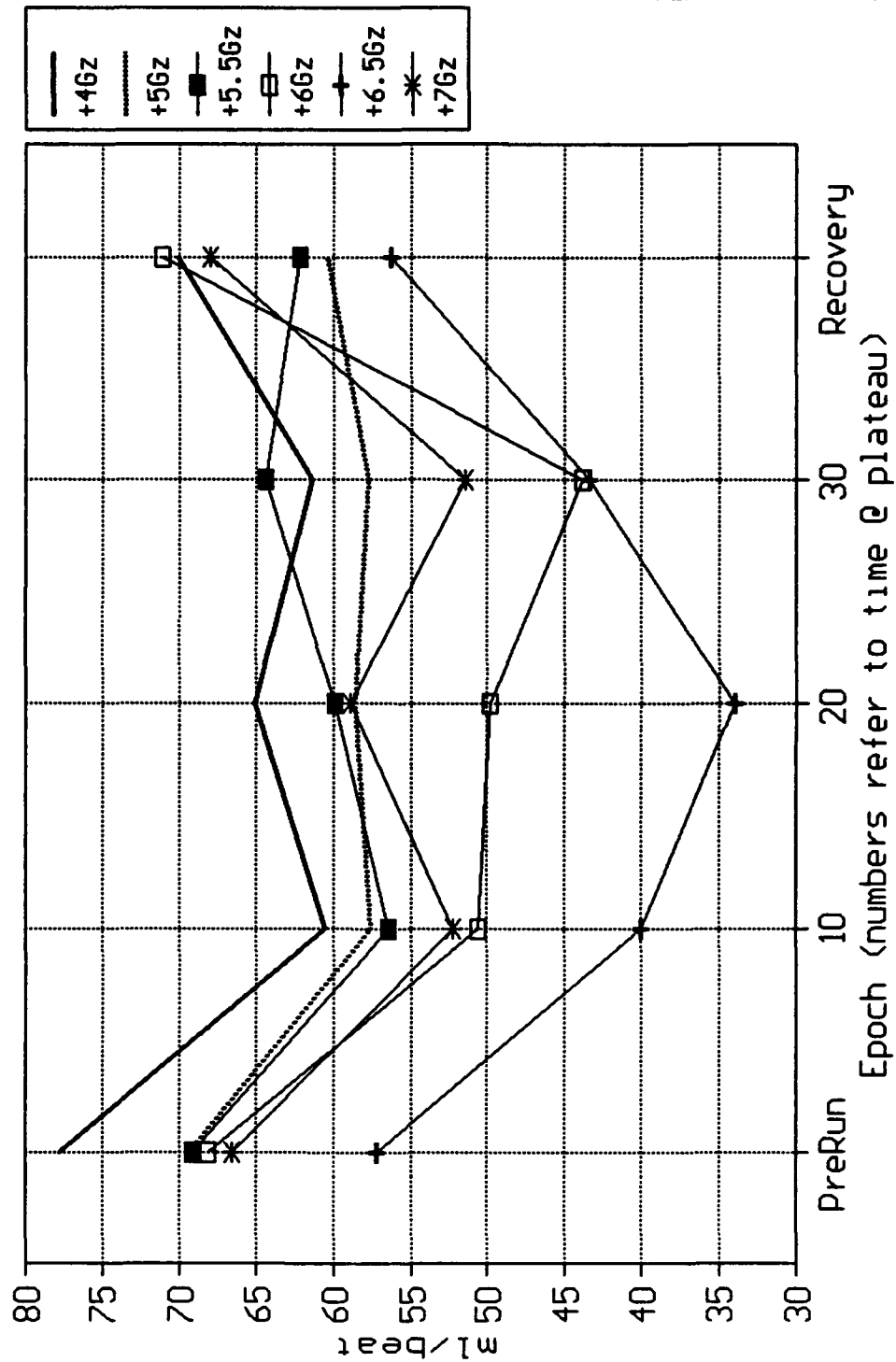


FIGURE 33. Mean Change in Contractility Index for Subjects Wearing TLSS

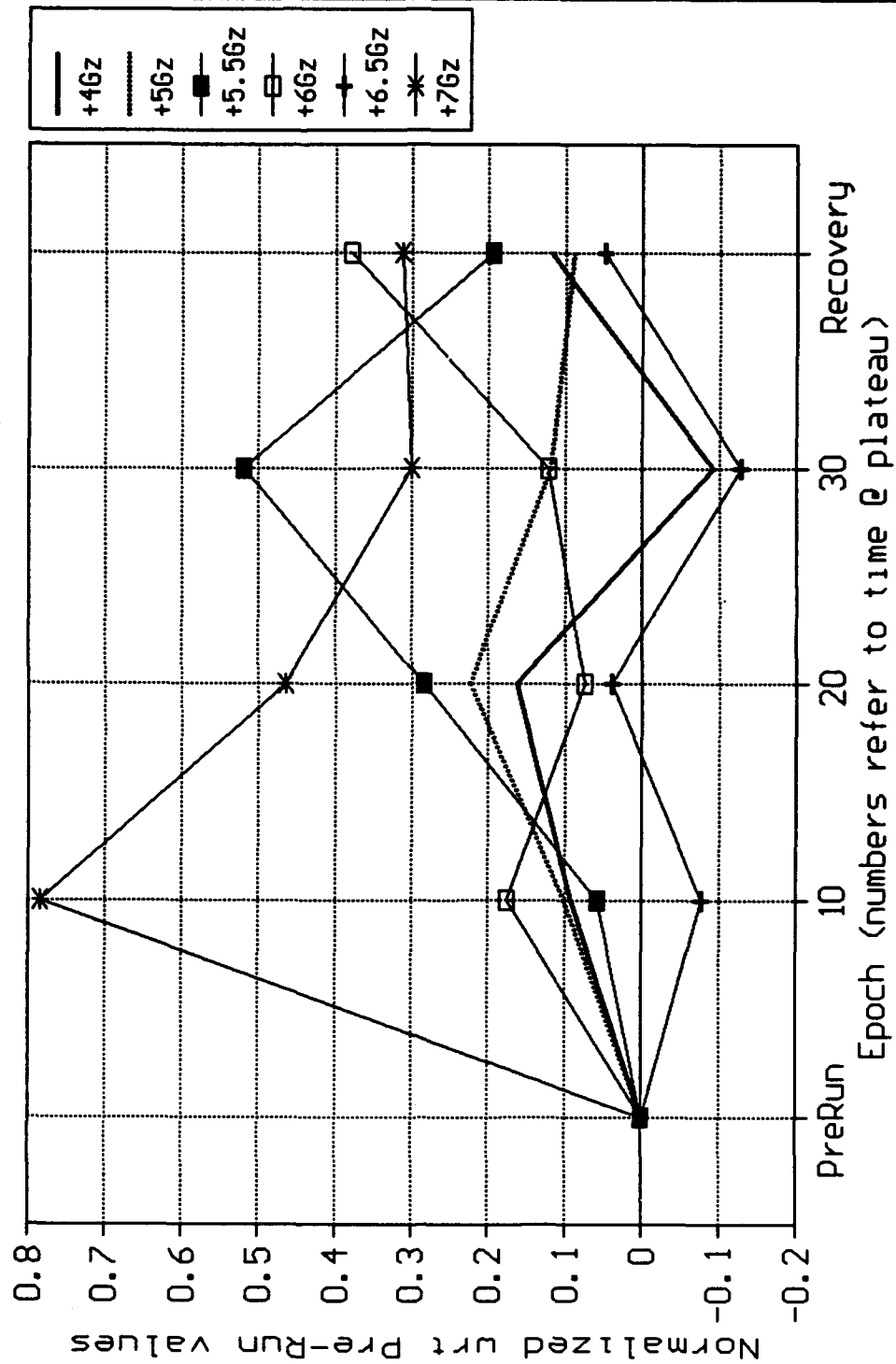


FIGURE 34. Mean Cardiac Contractility Index for Subjects Wearing TLSS

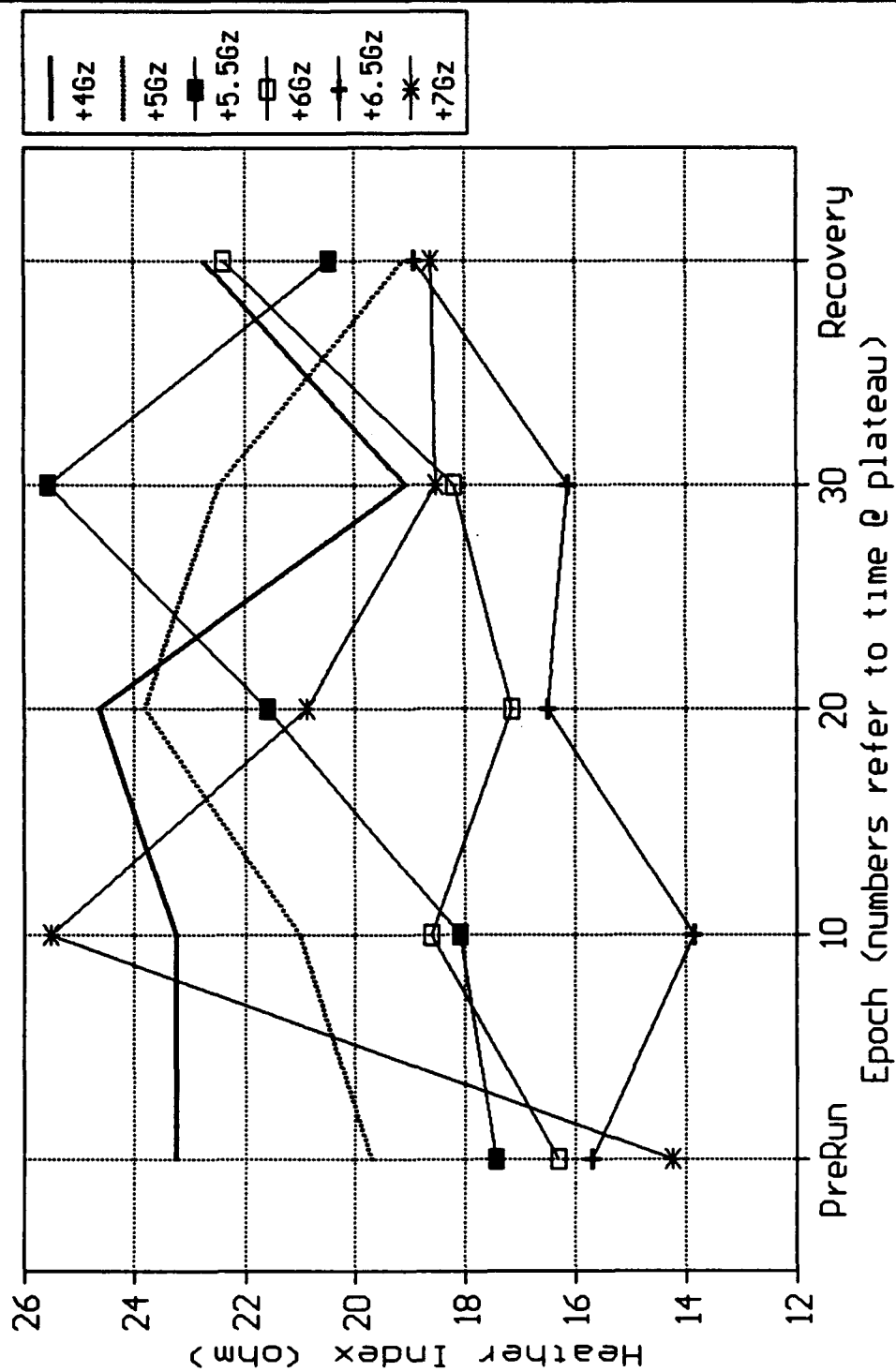


FIGURE 35. Mean Change in Heart Rate  
for Subjects Wearing TLSS

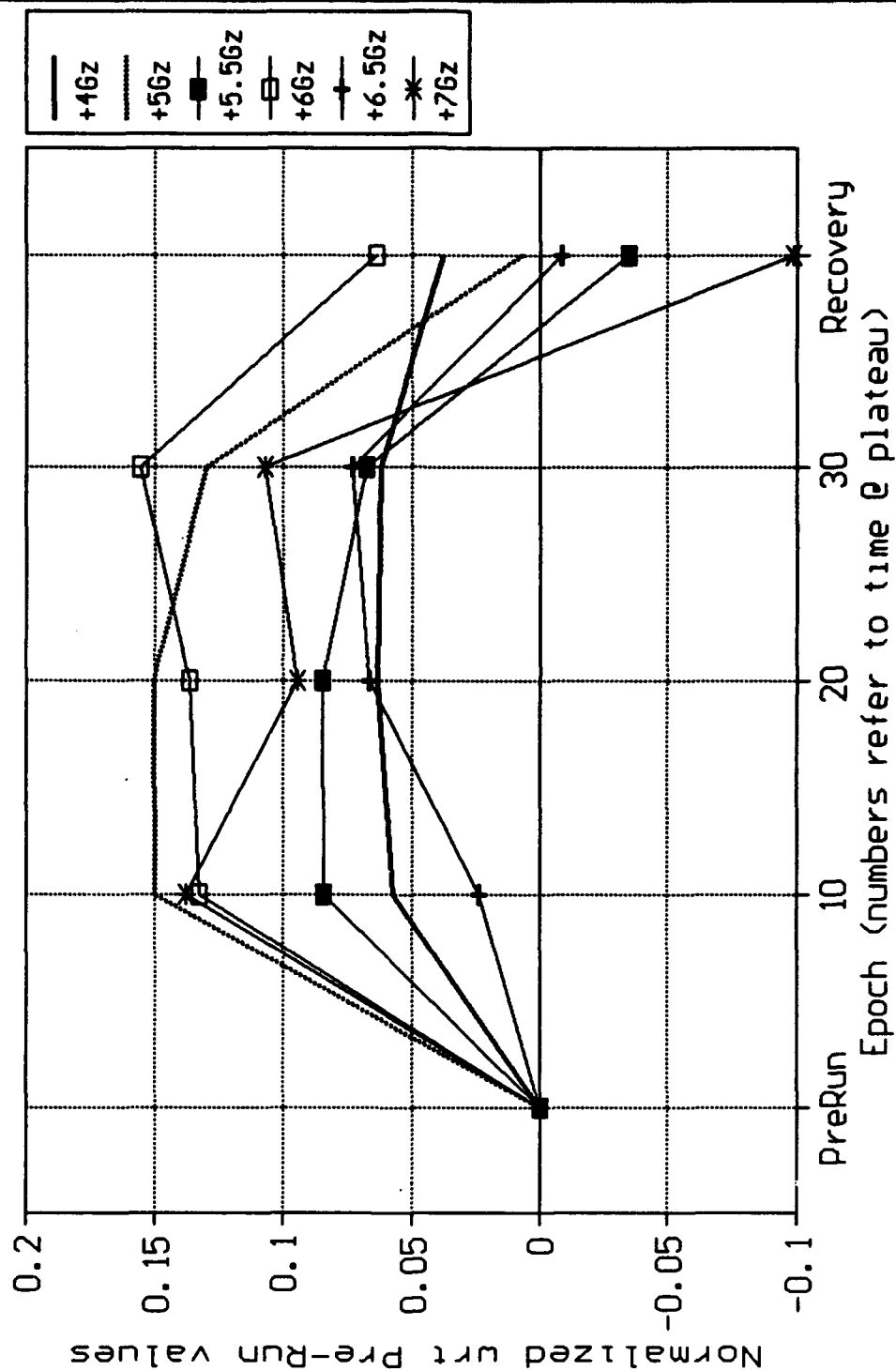


FIGURE 36. Mean Heart Rate  
for Subjects Wearing TLSS

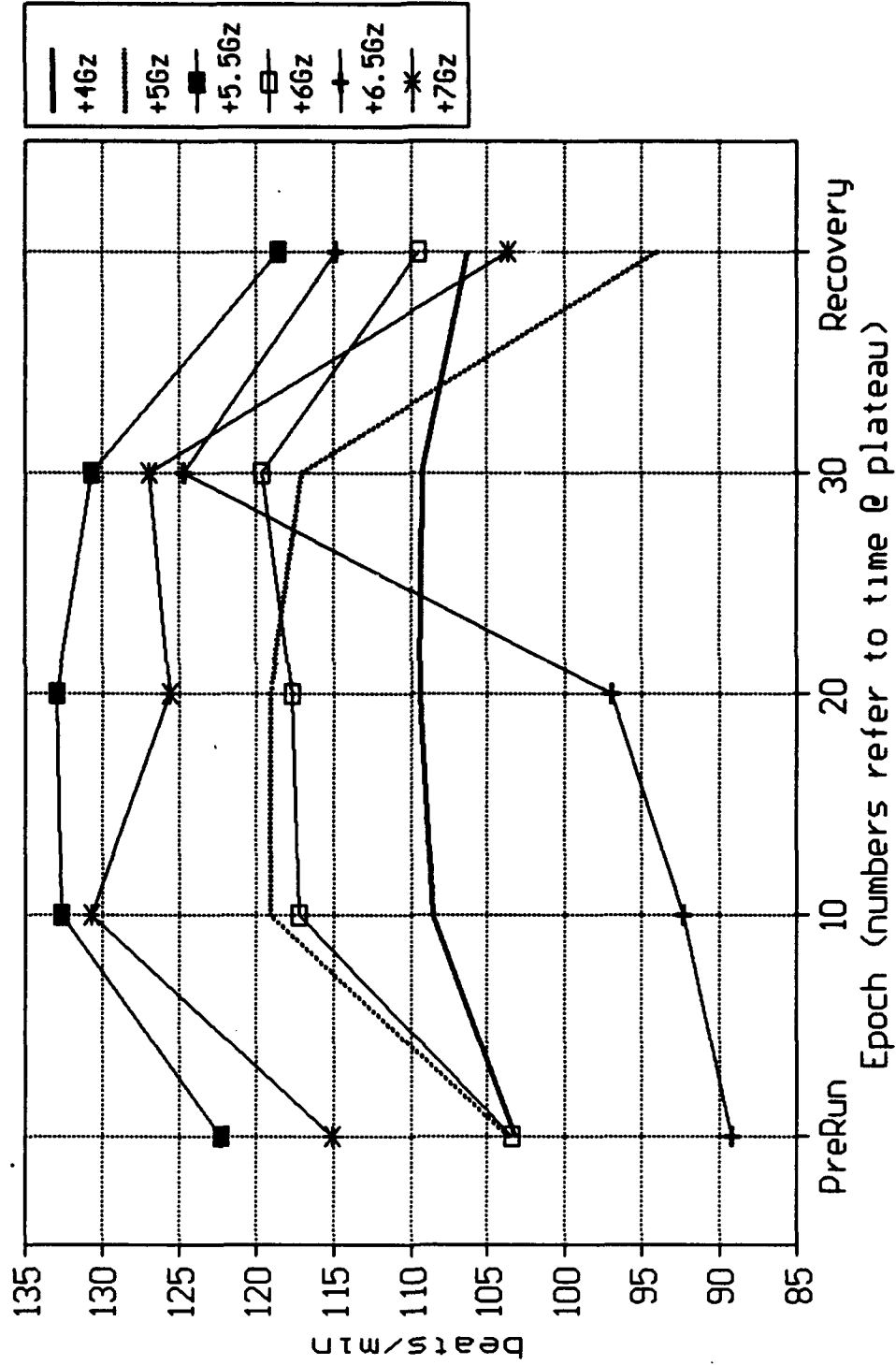


FIGURE 37. Mean Change in Pulse Wave Delay for Subjects Wearing TLSS

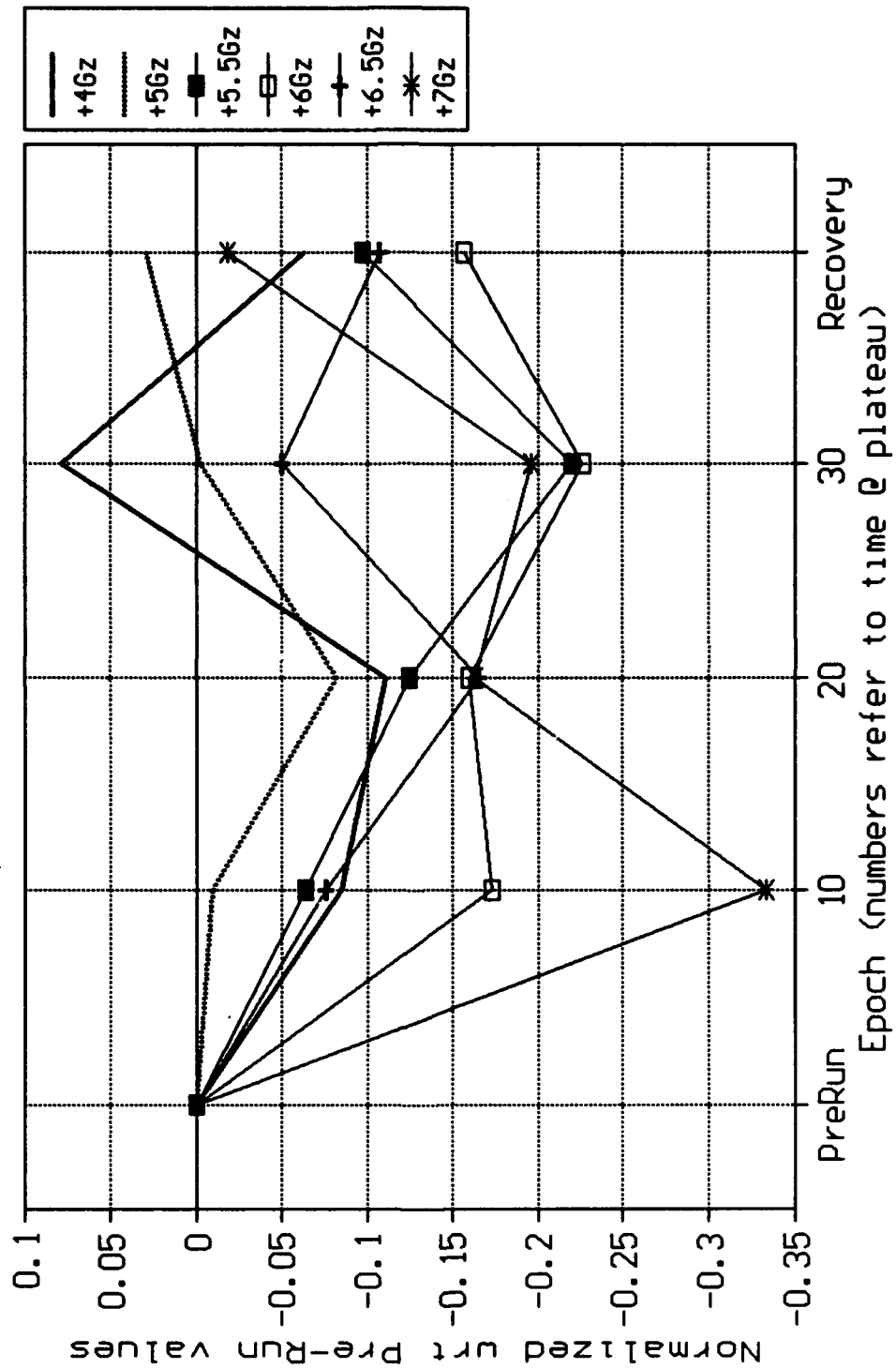
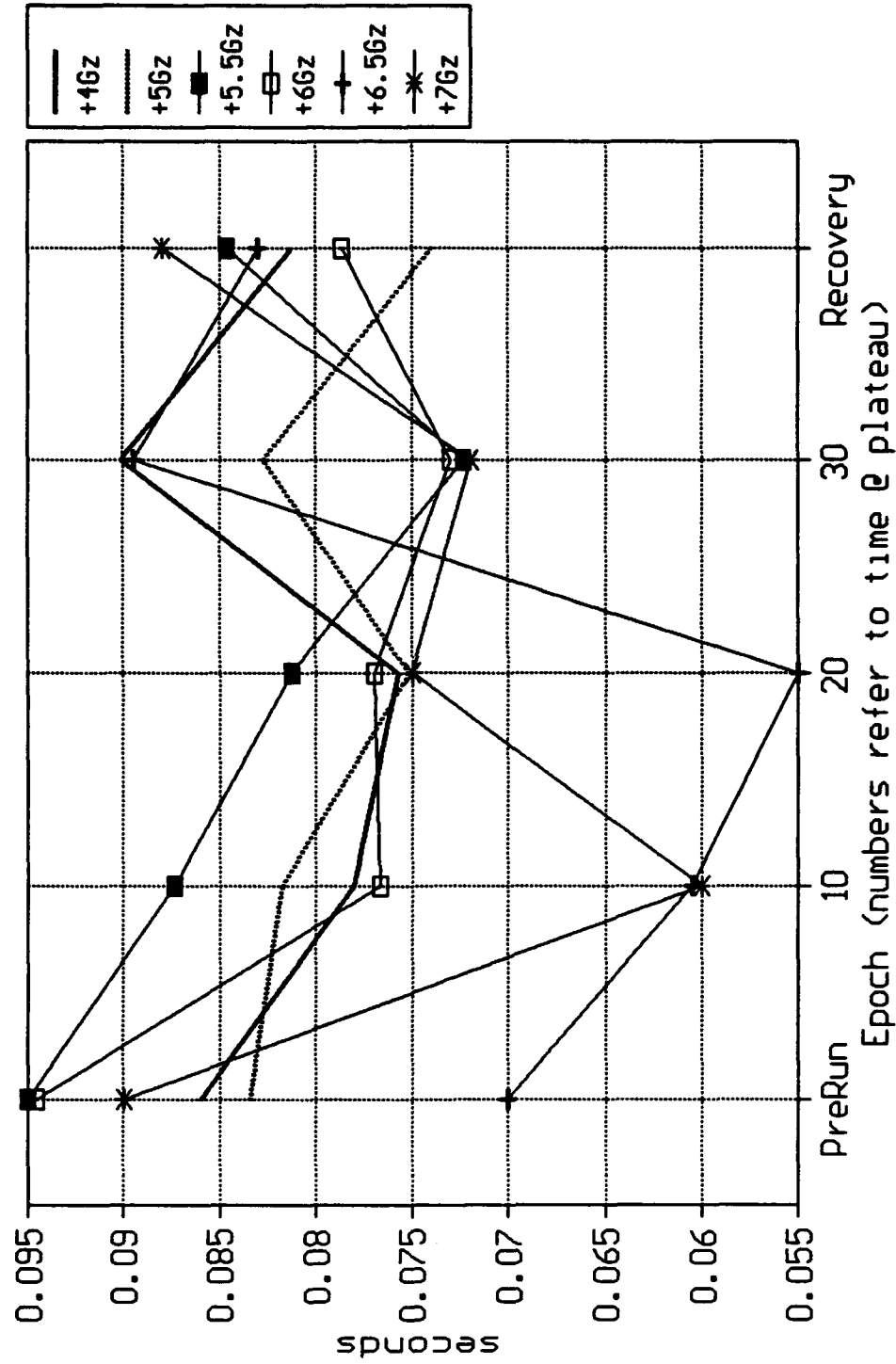


FIGURE 38. Mean Pulse Wave Delay  
for Subjects Wearing TLSS



## APPENDIX A

### CALCULATED CARDIAC INDICES FOR EACH SUBJECT

#### KEY:

PWD:	pulse wave delay (sec)
SV:	stroke volume (ml/beat)
CO:	cardiac output (liters/min)
HI:	Heather index of cardiac contractility ( $\Omega$ )
SI:	stroke index (ml/beat/m <sup>2</sup> )
CI:	cardiac index (L/min/m <sup>2</sup> )
bt:	beat
PLL:	60° peripheral light loss
G-LOC:	+Gz-induced loss of consciousness
GOR:	gradual onset rate run
ROR:	rapid onset rate run

Normalized parameters (relative to pre-run values for each run) are expressed as a fraction - for example, -0.49 refers to a 49% decrease with respect to pre-run values. These are referred to in the body of the report as  $\Delta SI$ ,  $\Delta CI$ ,  $\Delta HI$ ,  $\Delta PWD$  and  $\Delta HR$ .

Missing cells occur when data was too noisy to analyze.

# NAWCADWAR-93086-60

## CARDIAC PARAMETERS CALCULATED DURING RELAXED ROR

SUBJECT: S1 SUIT: TLSS DATE: 9/17/91

### +4 Gz

Time @ Plateau-s	PdD (s)	SV (ml/beat)	HR (bpm)	CO (L/min)	HI (ohm)	SI (ml/bt/m2)	CI (L/bt/m2)	SI	CI	HI	PdD	HR
								Normalized to 0				
Pre-Run	0.056	98.189	111.1	10.909	40.946	60.685	6.742	0.000	0.000	0.000	0.000	0.000
10	0.060	104.659	102.3	10.707	36.447	64.684	6.617	0.066	-0.019	-0.110	0.071	-0.079
20	0.060	80.671	102.3	8.253	32.626	49.858	5.101	-0.178	-0.243	-0.203	0.071	-0.079
30	0.100	73.194	107.1	7.839	20.000	45.237	4.845	-0.255	-0.281	-0.512	0.786	-0.036
Recovery	0.048	117.891	113.2	13.345	47.328	72.862	8.248	0.201	0.223	0.156	-0.143	0.019

### +5 Gz

Pre-Run	0.067	91.594	107.1	9.810	30.896	56.609	6.063	0.000	0.000	0.000	0.000	0.000
10	0.090	88.166	111.1	9.795	22.482	54.491	6.054	-0.037	-0.001	-0.272	0.343	0.037
20	0.067	85.060	112.5	9.569	34.858	52.571	5.914	-0.071	-0.025	0.128	0.000	0.050
30	0.053	98.150	111.1	10.904	44.466	60.661	6.739	0.072	0.112	0.439	-0.209	0.037
Recovery	0.072	94.609	105.3	9.962	32.732	58.473	6.157	0.033	0.016	0.059	0.075	-0.017

### +6 Gz

Pre-Run	0.040	113.083	100.0	11.308	54.671	69.891	6.989	0.000	0.000	0.000	0.000	0.000
10		87.033	118.4	10.305		53.790	6.369	-0.230	-0.089			0.184
20		109.037	107.1	11.678		67.390	7.217	-0.036	0.033			0.071
30	0.053	91.837	111.1	10.203	47.671	56.760	6.306	-0.188	-0.098	-0.128	0.325	0.111
Recovery	0.080	108.970	113.2	12.335	31.582	67.348	7.624	-0.036	0.091	-0.422	1.000	0.132

### +7 Gz

Pre-Run	0.053	110.115	123.0	13.544	43.665	68.056	8.371	0.000	0.000	0.000	0.000	0.000
10		91.242	136.4	12.445		56.392	7.692	-0.171	-0.081			0.109
20		111.875	125.0	13.984		69.144	8.643	0.016	0.033			0.016
30		98.698	125.0	12.337		61.000	7.625	-0.104	-0.089			0.016
Recovery		102.434	107.1	10.971		63.309	6.780	-0.070	-0.190			-0.129

### +8 Gz

Pre-Run	0.050	119.563	117.2	14.013	48.408	73.896	8.661	0.000	0.000	0.000	0.000	0.000
10		75.695	136.4	10.325		46.783	6.381	-0.367	-0.263			0.164
20		86.226	140.6	12.123		53.292	7.493	-0.279	-0.135			0.200
30		84.062	150.0	12.609		51.954	7.793	-0.297	-0.100			0.280
Recovery		133.974	136.4	18.274		82.802	11.294	0.121	0.304			0.164

### +9.5 Gz PLL Run

Pre-Run	0.060	116.999	119.0	13.923	35.173	72.311	8.605	0.000	0.000	0.000	0.000	0.000
7		98.539	141.5	13.943		60.902	8.618	-0.158	0.001			0.189
Recovery		117.246	122.4	14.351		72.463	8.870	0.002	0.031			0.029

# NAWCADWAR-93086-60

## CARDIAC PARAMETERS CALCULATED DURING RELAXED ROR

SUBJECT: S2 SUIT: TLSS DATE: 9/16/91

### +4 Gz

Time @ Plateau-s	PMD (s)	SV (ml/beat)	HR (bpm)	CO (L/min)	HI (ohm)	SI (ml/bt/m2)	CI (L/bt/m2)	SI Normalized to 0	CI Normalized to 0	HI Normalized to 0	PMD Normalized to 0	HR Normalized to 0
Pre-Run	0.093	54.199	111.1	6.022	16.674	33.129	3.681	0.000	0.000	0.000	0.000	0.000
10	0.066	39.702	102.1	4.054	21.559	24.267	2.478	-0.267	-0.327	0.293	-0.290	-0.081
20	0.064	43.219	107.1	4.629	23.610	26.417	2.829	-0.203	-0.231	0.416	-0.312	-0.036
30	0.076	37.773	107.6	4.064	17.273	23.089	2.484	-0.303	-0.325	0.036	-0.183	-0.032
Recovery	0.096	55.025	105.3	5.794	17.162	33.634	3.542	0.015	-0.038	0.029	0.032	-0.052

### +5 Gz

Pre-Run	0.088	52.713	106.0	5.588	17.371	32.220	3.415	0.000	0.000	0.000	0.000	0.000
10	0.066	33.774	112.2	3.789	17.621	20.644	2.316	-0.359	-0.322	0.014	-0.250	0.058
20	0.066	37.382	116.5	4.355	19.690	22.850	2.662	-0.291	-0.221	0.134	-0.250	0.099
30	0.080	34.900	108.6	3.790	14.758	21.333	2.317	-0.338	-0.322	-0.150	-0.091	0.025
Recovery	0.094	53.668	92.0	4.937	16.871	32.804	3.018	0.018	-0.116	-0.029	0.068	-0.132

### +6 Gz

Pre-Run	0.093	50.646	99.3	5.029	16.247	30.957	3.074	0.000	0.000	0.000	0.000	0.000
10	0.058	40.969	110.6	4.531	26.356	25.042	2.770	-0.191	-0.099	0.622	-0.376	0.114
20	0.062	37.737	118.2	4.461	22.879	23.067	2.726	-0.255	-0.113	0.408	-0.333	0.190
30	0.066	36.356	116.5	4.235	20.691	22.222	2.589	-0.282	-0.158	0.274	-0.290	0.173
Recovery	0.088	55.972	115.9	6.487	20.024	34.213	3.965	0.105	0.290	0.232	-0.054	0.167

### +6.5 Gz

Pre-Run	0.095	56.092	117.6	6.596	18.595	34.286	4.032	0.000	0.000	0.000	0.000	0.000
10	0.066	40.235	114.3	4.599	21.092	24.594	2.811	-0.283	-0.303	0.134	-0.305	-0.028
20	0.064	40.697	123.1	5.010	23.954	24.876	3.062	-0.274	-0.241	0.288	-0.326	0.047
30	0.068	40.137	127.7	5.126	21.314	24.534	3.133	-0.264	-0.223	0.146	-0.284	0.086
Recovery	0.092	58.926	109.6	6.458	17.908	36.018	3.948	0.051	-0.021	-0.037	-0.032	-0.068

### +7 Gz PLL Run

Pre-Run	0.093	52.770	113.6	5.995	18.237	32.255	3.664	0.000	0.000	0.000	0.000	0.000
6	0.062	40.015	127.0	5.082	24.229	24.459	3.106	-0.242	-0.152	0.329	-0.333	0.118
Recovery	0.084	58.937	103.9	6.124	21.502	36.025	3.743	0.117	0.022	0.179	-0.097	-0.085

# NAWCADWAR-93086-60

## CARDIAC PARAMETERS CALCULATED DURING RELAXED ROR

SUBJECT: S2 SUIT: TLSS DATE: 9/18/91

### +4 Gz

Time @	PWD	SV	HR	CO	HI	SI	CI	SI	CI	HI	PWD	HR
Plateau-s	(s)	(ml/beat)	(bpm)	(L/min)	(ohm)	(ml/bt/m2)	(L/bt/m2)	Normalized to 0				
Pre-Run	0.087	51.796	93.8	4.858	17.880	31.660	2.970	0.000	0.000	0.000	0.000	0.000
10	0.080	32.657	103.4	3.377	20.697	19.961	2.064	-0.370	-0.305	0.158	-0.080	0.102
20	0.053	49.415	112.6	5.564	37.777	30.205	3.401	-0.046	0.145	1.113	-0.391	0.200
30	0.110	32.835	107.1	3.517	14.755	20.071	2.150	-0.366	-0.276	-0.175	0.264	0.142
Recovery	0.080	55.623	90.0	5.006	22.549	34.000	3.060	0.074	0.030	0.261	-0.080	-0.041

\*\*\* NOTE: +5Gz Run Too Noisy To Analyze \*\*\*

### +6 Gz

Pre-Run	0.087	50.346	101.4	5.105	18.932	30.774	3.120	0.000	0.000	0.000	0.000	0.000
10	0.080	16.883	125.0	2.110	12.527	10.320	1.290	-0.665	-0.587	-0.338	-0.080	0.233
20	0.080	28.163	128.5	3.619	15.142	17.215	2.212	-0.441	-0.291	-0.200	-0.080	0.267
30	0.070	20.643	128.5	2.653	15.998	12.618	1.621	-0.590	-0.480	-0.155	-0.195	0.267
Recovery	0.080	49.790	109.1	5.432	20.997	30.434	3.320	-0.011	0.064	0.109	-0.080	0.076

### +7 Gz

Pre-Run	0.093	38.791	110.3	4.279	14.009	23.711	2.615	0.000	0.000	0.000	0.000	0.000
10	0.064	28.715	133.3	3.828	20.221	17.552	2.340	-0.260	-0.105	0.443	-0.312	0.209
20	0.070	30.182	136.4	4.117	21.164	18.448	2.516	-0.222	-0.038	0.511	-0.247	0.237
30	0.064	27.525	140.5	3.867	19.608	16.824	2.364	-0.290	-0.096	0.400	-0.312	0.274
Recovery	0.080	52.430	98.4	5.159	23.148	32.048	3.154	0.352	0.206	0.652	-0.140	-0.108

### +7.5 Gz

Pre-Run	0.080	46.608	121.0	5.640	17.593	28.489	3.447	0.000	0.000	0.000	0.000	0.000
10	0.072	28.156	130.4	3.672	17.429	17.210	2.244	-0.396	-0.349	-0.009	-0.100	0.078
20	0.064	32.052	139.5	4.471	21.310	19.592	2.733	-0.312	-0.207	0.211	-0.200	0.153
30	0.064	27.129	140.5	3.812	19.880	16.583	2.330	-0.418	-0.324	0.130	-0.200	0.161
Recovery	0.080	43.819	132.5	5.806	18.301	26.784	3.549	-0.060	0.030	0.040	0.000	0.095

### +8 Gz PLL Run

Pre-Run	0.087	41.975	117.2	4.919	16.127	25.657	3.007	0.000	0.000	0.000	0.000	0.000
4	0.072	26.035	136.4	3.551	16.340	15.914	2.171	-0.380	-0.278	0.013	-0.172	0.164
Recovery	0.072	41.554	125.0	5.194	18.942	25.400	3.175	-0.010	0.056	0.175	-0.172	0.067

# NAWCADWAR-93086-60

## CARDIAC PARAMETERS CALCULATED DURING RELAXED ROR

SUBJECT: S3 SUIT: TLSS DATE: 9/17/91

### +4 Gz

Time @ Plateau-s	PWD (s)	SV (ml/beat)	HR (bpm)	CO (L/min)	HI (ohm)	SI (ml/bt/m2)	CI (L/bt/m2)	SI Normalized to 0	CI Normalized to 0	HI Normalized to 0	PWD	HR
Pre-Run	0.100	63.893	94.9	6.063	15.803	33.646	3.193	0.000	0.000	0.000	0.000	0.000
10	0.112	77.191	93.8	7.241	15.756	40.648	3.813	0.208	0.194	-0.003	0.120	-0.012
20	0.104	65.128	101.7	6.623	14.014	34.296	3.488	0.019	0.092	-0.113	0.040	0.072
30	0.104	72.753	100.0	7.275	15.871	38.311	3.831	0.139	0.200	0.004	0.040	0.054
Recovery	0.096	92.737	90.9	8.430	20.120	48.835	4.439	0.451	0.390	0.273	-0.040	-0.042

### +5 Gz

Pre-Run	0.100	72.194	101.4	7.320	15.101	38.017	3.855	0.000	0.000	0.000	0.000	0.000
10	0.104	67.299	105.3	7.087	15.955	35.439	3.732	-0.068	-0.032	0.057	0.040	0.038
20	0.080	61.661	107.1	6.604	19.425	32.470	3.478	-0.146	-0.098	0.286	-0.200	0.056
30	0.105	48.445	103.4	5.009	15.134	25.511	2.638	-0.329	-0.316	0.002	0.050	0.020
Recovery	0.088	91.672	98.4	9.021	20.652	48.274	4.750	0.270	0.232	0.368	-0.120	-0.030

### +6 Gz

Pre-Run	0.113	81.321	104.2	8.474	15.306	42.823	4.462	0.000	0.000	0.000	0.000	0.000
10	0.090	59.660	107.1	6.390	17.559	31.417	3.365	-0.266	-0.246	0.147	-0.204	0.028
20	0.072	31.863	107.1	3.413	12.316	16.779	1.797	-0.608	-0.597	-0.195	-0.363	0.028
30	0.100	32.832	115.4	3.789	9.658	17.289	1.995	-0.596	-0.553	-0.369	-0.115	0.107
Recovery	0.080	88.413	101.7	8.992	27.436	46.558	4.735	0.087	0.061	0.793	-0.292	-0.024

### +6.5 Gz

Pre-Run	0.113	112.342	100.0	11.234	21.056	59.159	5.916	0.000	0.000	0.000	0.000	0.000
10	0.088	70.135	101.7	7.133	17.160	36.932	3.756	-0.376	-0.365	-0.185	-0.221	0.017
20	0.100	44.220	111.1	4.913	12.291	23.286	2.587	-0.606	-0.563	-0.416	-0.115	0.111
30	0.110	35.010	112.5	3.939	9.658	18.436	2.074	-0.688	-0.649	-0.541	-0.027	0.125
Recovery	0.096	87.686	105.3	9.233	18.017	46.175	4.862	-0.219	-0.178	-0.144	-0.150	0.053

### +7 Gz PLL Run

Pre-Run	0.100	101.334	101.4	10.275	19.052	53.362	5.411	0.000	0.000	0.000	0.000	0.000
7	0.090	55.514	115.4	6.406	16.037	29.233	3.373	-0.452	-0.377	-0.158	-0.100	0.138
Recovery	0.088	91.973	98.4	9.050	20.632	48.432	4.766	-0.092	-0.119	0.083	-0.120	-0.030

# NAWCADWAR-93086-60

## CARDIAC PARAMETERS CALCULATED DURING RELAXED ROR

SUBJECT: S3 SUIT: TLSS DATE: 9/19/91

### +4 Gz

Time @ Plateau-s	PWD (s)	SV (ml/beat)	HR (bpm)	CO (L/min)	HI (ohm)	SI (ml/bt/m2)	CI (L/bt/m2)	SI Normalized to 0	CI Normalized to 0	HI Normalized to 0	PWD Normalized to 0	HR Normalized to 0
Pre-Run	0.087	89.966	92.6	8.331	22.864	47.376	4.387	0.000	0.000	0.000	0.000	0.000
10	0.072	63.738	113.2	7.215	26.308	33.564	3.799	-0.292	-0.134	0.151	-0.172	0.222
20	0.088	82.689	103.4	8.550	20.788	43.544	4.502	-0.081	0.026	-0.091	0.011	0.117
30	0.100	73.746	107.1	7.898	16.458	38.834	4.159	-0.180	-0.052	-0.280	0.149	0.157
Recovery	0.088	73.277	101.7	7.452	22.065	38.587	3.924	-0.186	-0.105	-0.035	0.011	0.098

### +5 Gz

Pre-Run	0.080	77.367	100.0	7.737	23.731	40.741	4.074	0.000	0.000	0.000	0.000	0.000
10	0.072	65.540	120.0	7.865	27.208	34.513	4.142	-0.153	0.017	0.147	-0.100	0.200
20	0.080	59.415	120.0	7.130	23.083	31.288	3.755	-0.232	-0.078	-0.027	0.000	0.200
30	0.072	62.756	115.4	7.242	25.648	33.047	3.814	-0.189	-0.064	0.081	-0.100	0.154
Recovery	0.088	73.857	98.4	7.268	23.365	38.893	3.827	-0.045	-0.061	-0.015	0.100	-0.016

### +5.5 Gz

Pre-Run	0.093	78.283	110.3	8.635	19.647	41.223	4.547	0.000	0.000	0.000	0.000	0.000
10	0.080	44.522	118.4	5.271	16.739	23.445	2.776	-0.431	-0.389	-0.148	-0.140	0.073
20	0.088	52.629	115.4	6.073	16.199	27.714	3.198	-0.328	-0.297	-0.176	-0.054	0.046
30	0.080	59.645	113.9	6.794	18.737	31.409	3.577	-0.238	-0.213	-0.046	-0.140	0.033
Recovery	0.088	67.759	98.4	6.667	20.641	35.681	3.511	-0.134	-0.228	0.051	-0.054	-0.108

### +6 Gz PLL Run

Pre-Run	0.087	82.605	86.2	7.121	20.506	43.499	3.750	0.000	0.000	0.000	0.000	0.000
5	0.070	64.647	123.3	7.971	27.337	34.043	4.197	-0.217	0.119	0.333	-0.195	0.430
Recovery	0.080	75.427	114.3	8.621	26.323	39.719	4.540	-0.087	0.211	0.284	-0.080	0.326

# NAWCADWAR-93086-60

## CARDIAC PARAMETERS CALCULATED DURING RELAXED ROR

SUBJECT: S4 SUIT: TLSS DATE: 9/16/91

### +4 Gz

Time @ Plateau-s	PWD (s)	SV (ml/beat)	HR (bpm)	CO (L/min)	HI (ohm)	SI (ml/bt/m2)	CI (L/bt/m2)	SI Normalized to 0	CI Normalized to 0	HI Normalized to 0	PWD	HR
Pre-Run	0.090	44.858	126.6	5.679	16.200	23.899	3.026	0.000	0.000	0.000	0.000	0.000
10	0.088	51.138	135.6	6.934	20.388	27.245	3.694	0.140	0.221	0.259	-0.022	0.071
20	0.082	50.807	138.7	7.047	22.238	27.068	3.754	0.133	0.241	0.373	-0.089	0.096
30	0.086	49.201	135.6	6.672	19.885	26.212	3.554	0.097	0.175	0.227	-0.044	0.071
Recovery	0.084	36.989	129.0	4.772	15.156	19.707	2.542	-0.175	-0.160	-0.064	-0.067	0.019

### +5 Gz

Pre-Run	0.082	35.860	114.9	4.120	15.731	19.105	2.195	0.000	0.000	0.000	0.000	0.000
10	0.076	54.165	151.9	8.228	26.426	28.857	4.383	0.510	0.997	0.680	-0.073	0.322
20	0.080	51.022	148.1	7.556	22.584	27.183	4.026	0.423	0.834	0.436	-0.024	0.289
30	0.076	52.688	152.9	8.056	25.155	28.070	4.292	0.469	0.955	0.599	-0.073	0.331
Recovery	0.076	39.990	121.7	4.867	20.898	21.305	2.593	0.115	0.181	0.328	-0.073	0.059

### +5.5 Gz

Pre-Run	0.085	44.585	131.6	5.867	17.252	23.753	3.126	0.000	0.000	0.000	0.000	0.000
10	0.102	51.567	147.2	7.591	16.230	27.473	4.044	0.157	0.294	-0.059	0.200	0.119
20	0.092	46.289	149.1	6.902	17.446	24.661	3.677	0.038	0.176	0.011	0.082	0.133
30	0.082	49.793	141.8	7.061	21.572	26.528	3.762	0.117	0.203	0.250	-0.035	0.078
Recovery	0.086	39.563	135.6	5.365	15.390	21.078	2.858	-0.113	-0.086	-0.108	0.012	0.030

### +6 Gz PLL Run

Pre-Run	0.082	40.613	122.4	4.971	18.805	21.637	2.648	0.000	0.000	0.000	0.000	0.000
10	0.094	56.273	154.8	8.711	18.416	29.980	4.641	0.386	0.752	-0.021	0.146	0.265
Recovery	0.084	43.610	129.0	5.626	20.158	23.234	2.997	0.074	0.132	0.072	0.024	0.054

# NAWCADWAR-93086-60

## CARDIAC PARAMETERS CALCULATED DURING RELAXED ROR

SUBJECT: S4 SUIT: TLSS DATE: 9/18/91

### +4 Gz

Time @ Plateau-s	PWD (s)	SV (ml/beat)	HR (bpm)	CO (L/min)	HI (ohm)	SI (ml/bt/m2)	CI (L/bt/m2)	SI Normalized to 0	CI Normalized to 0	HI Normalized to 0	PWD	HR
Pre-Run	0.080	173.542	107.1	18.586	49.307	92.457	9.902	0.000	0.000	0.000	0.000	0.000
10	0.080	84.496	112.5	9.506	28.785	45.017	5.064	-0.513	-0.489	-0.416	0.000	0.050
20	0.067	90.588	115.4	10.454	35.006	48.262	5.569	-0.478	-0.438	-0.290	-0.163	0.077
30	0.070	102.479	112.5	11.529	31.069	54.597	6.142	-0.409	-0.380	-0.370	-0.125	0.050

Recovery was too noisy to analyze

### +5 Gz

Pre-Run	0.100	121.012	93.8	11.351	18.038	64.471	6.047	0.000	0.000	0.000	0.000	0.000
10	0.104	63.938	130.4	8.337	19.005	34.064	4.442	-0.472	-0.265	0.054	0.040	0.390
20	0.080	82.277	133.3	10.968	32.249	43.834	5.843	-0.320	-0.034	0.788	-0.200	0.421
30	0.107	62.092	125.0	7.761	20.326	33.080	4.135	-0.487	-0.316	0.127	0.070	0.333

Recovery was too noisy to analyze

### +5.5 Gz

Pre-Run	0.107	84.631	125.0	10.579	15.424	45.089	5.636	0.000	0.000	0.000	0.000	0.000
10	0.080	73.132	132.4	9.683	21.295	38.962	5.159	-0.136	-0.085	0.381	-0.252	0.059
20	0.064	80.855	134.3	10.859	31.150	43.077	5.785	-0.045	0.026	1.020	-0.402	0.074
30	0.055	83.793	136.4	11.429	36.325	44.642	6.089	-0.010	0.080	1.355	-0.486	0.091
Recovery	0.080	79.172	121.6	9.627	25.293	42.180	5.129	-0.065	-0.090	0.640	-0.252	-0.027

### +6 Gz PLL Run

Pre-Run	0.104	89.540	115.4	10.333	20.112	47.704	5.505	0.000	0.000	0.000	0.000	0.000
9	0.080	66.871	136.4	9.121	21.535	35.626	4.859	-0.253	-0.117	0.071	-0.231	0.182

Recovery was too noisy to analyze

# NAWCADWAR-93086-60

## CARDIAC PARAMETERS CALCULATED DURING RELAXED ROR

SUBJECT: S4 SUIT: TLSS DATE: 9/19/91

### +4 Gz

Time @ Plateau-s	PWD (s)	SV (ml/beat)	HR (bpm)	CO (L/min)	HI (ohm)	SI (ml/bt/m2)	CI (L/bt/m2)	SI	CI	HI	PWD	HR
								Normalized to 0				
Pre-Run	0.087	76.615	108.7	8.328	20.480	40.818	4.437	0.000	0.000	0.000	0.000	0.000
10	0.080	67.665	113.2	7.660	22.669	36.049	4.081	-0.117	-0.080	0.107	-0.080	0.041
20	0.080	77.286	120.0	9.274	22.431	41.175	4.941	0.009	0.114	0.095	-0.080	0.104
30	0.080	68.467	121.6	8.326	21.081	36.477	4.436	-0.106	0.000	0.029	-0.080	0.119
Recovery	0.080	84.099	120.0	10.092	25.397	44.805	5.377	0.098	0.212	0.240	-0.080	0.104

### +5 Gz

Pre-Run	0.087	72.875	110.3	8.038	21.868	38.825	4.282	0.000	0.000	0.000	0.000	0.000
10	0.080	57.843	130.4	7.543	20.842	30.817	4.019	-0.206	-0.062	-0.047	-0.080	0.182
20	0.064	60.195	127.7	7.687	28.535	32.070	4.095	-0.174	-0.044	0.305	-0.264	0.158
30	0.064	58.871	128.6	7.571	25.986	31.365	4.033	-0.192	-0.058	0.188	-0.264	0.166
Recovery	0.080	64.846	120.0	7.782	21.504	34.548	4.146	-0.110	-0.032	-0.017	-0.080	0.088

### +6 Gz

Pre-Run	0.087	70.259	121.0	8.501	20.919	37.432	4.529	0.000	0.000	0.000	0.000	0.000
10	0.080	61.693	146.3	9.026	20.657	32.868	4.809	-0.122	0.062	-0.013	-0.080	0.209
20	0.080	60.333	146.3	8.827	20.736	32.143	4.703	-0.141	0.038	-0.009	-0.080	0.209
30	0.060	50.014	145.2	7.262	28.001	26.646	3.869	-0.288	-0.146	0.339	-0.310	0.200
Recovery	0.064	72.553	109.1	7.915	30.853	38.654	4.217	0.033	-0.069	0.475	-0.264	-0.098

### +6.5 Gz

Pre-Run	0.072	60.208	138.9	8.363	23.099	32.077	4.455	0.000	0.000	0.000	0.000	0.000
10	0.088	49.630	153.3	7.608	17.142	26.441	4.053	-0.176	-0.090	-0.258	0.222	0.104
20	0.056	50.898	153.8	7.828	29.775	27.117	4.171	-0.155	-0.064	0.289	-0.222	0.107
30	0.080	53.332	150.0	8.000	20.365	28.414	4.262	-0.114	-0.043	-0.118	0.111	0.080
Recovery	0.080	50.782	133.3	6.769	19.174	27.055	3.606	-0.157	-0.191	-0.170	0.111	-0.040

### +7 Gz PLL Run

Pre-Run	0.093	58.783	119.0	6.995	16.494	31.318	3.727	0.000	0.000	0.000	0.000	0.000
6	0.080	49.023	145.2	7.118	19.544	26.118	3.792	-0.166	0.018	0.185	-0.140	0.220

Recovery	0.080	68.821	127.7	8.788	21.504	36.665	4.682	0.171	0.256	0.304	-0.140	0.073
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# NAWCADWAR-93086-60

## CARDIAC PARAMETERS CALCULATED DURING RELAXED ROR

SUBJECT: S5 SUIT: TLSS DATE: 9/20/91

+4 Gz												
Time s	PWD	SV	HR	CO	HI	SI	CI	SI	CI	HI	PWD	HR
Plateau-s	(s)	(ml/beat)	(bpm)	(L/min)	(ohm)	(ml/bt/m2)	(L/bt/m2)	Normalized to 0				
Pre-Run	0.080	63.053	88.2	5.561	17.727	33.557	2.960	0.000	0.000	0.000	0.000	0.000
10	0.072	53.075	98.4	5.223	20.588	28.246	2.779	-0.158	-0.061	0.161	-0.100	0.116
20	0.080	75.457	89.6	6.761	20.962	40.158	3.598	0.197	0.216	0.183	0.000	0.016
30	0.088	66.512	91.5	6.086	18.504	35.398	3.239	0.055	0.094	0.044	0.100	0.037
Recovery	0.080	58.278	100.0	5.828	15.929	31.015	3.102	-0.076	0.048	-0.101	0.000	0.134
+5 Gz												
Pre-Run	0.067	47.660	97.4	4.642	17.105	25.364	2.470	0.000	0.000	0.000	0.000	0.000
10	0.080	58.853	101.7	5.985	20.216	31.322	3.185	0.235	0.289	0.182	0.194	0.044
20	0.080	60.754	101.7	6.179	18.114	32.333	3.288	0.275	0.331	0.059	0.194	0.044
30	0.100	68.646	103.4	7.098	16.040	36.533	3.778	0.440	0.529	-0.062	0.493	0.062
Recovery	0.080	76.704	102.7	7.878	20.603	40.822	4.192	0.609	0.697	0.205	0.194	0.054
+6 Gz												
Pre-Run	0.080	54.723	102.0	5.582	13.744	29.123	2.971	0.000	0.000	0.000	0.000	0.000
10	0.088	63.291	100.0	6.329	17.548	33.683	3.368	0.157	0.134	0.277	0.100	-0.020
20	0.104	53.239	105.6	5.622	11.977	28.334	2.992	-0.027	0.007	-0.129	0.300	0.035
30	0.072	52.275	111.9	5.850	17.976	27.821	3.113	-0.045	0.048	0.308	-0.100	0.097
Recovery	0.080	60.803	110.3	6.707	16.012	32.359	3.569	0.111	0.202	0.165	0.000	0.081
+6.5 Gz PLL Run												
Pre-Run	0.073	55.957	107.1	5.993	17.881	29.780	3.189	0.000	0.000	0.000	0.000	0.000
10	0.093	51.430	107.1	5.508	14.083	27.371	2.931	-0.081	-0.081	-0.212	0.274	0.000
Recovery	0.072	70.813	100.0	7.081	22.124	37.687	3.769	0.265	0.182	0.237	-0.014	-0.066

# NAWCADWAR-93086-60

## CARDIAC PARAMETERS CALCULATED DURING RELAXED ROR

SUBJECT: S6 SUIT: TLSS DATE: 9/18/91

### +4 Gz

Time @ Plateau-s	PMD (s)	SV (ml/beat)	HR (bpm)	CO (L/min)	HI (ohm)	SI (ml/bt/m2)	CI (L/bt/m2)	SI Normalized to 0	CI Normalized to 0	HI Normalized to 0	PMD Normalized to 0	HR Normalized to 0
Pre-Run	0.100	61.982	97.4	6.037	14.651	32.639	3.179	0.000	0.000	0.000	0.000	0.000
10	0.070	31.454	111.1	3.495	19.269	16.564	1.840	-0.493	-0.421	0.315	-0.300	0.141
20	0.080	35.662	103.4	3.687	16.755	18.779	1.942	-0.425	-0.389	0.144	-0.200	0.062
30	0.088	37.165	102.3	3.802	15.640	19.571	2.002	-0.400	-0.370	0.067	-0.120	0.050
Recovery	0.080	56.300	107.1	6.030	19.133	29.647	3.175	-0.092	-0.001	0.306	-0.200	0.100

### +5 Gz

Pre-Run	0.080	53.310	101.4	5.406	17.389	28.073	2.847	0.000	0.000	0.000	0.000	0.000
10	0.064	28.858	109.1	3.148	19.193	15.196	1.658	-0.459	-0.418	0.104	-0.200	0.076
20	0.080	29.790	105.3	3.137	15.909	15.687	1.652	-0.441	-0.420	-0.085	0.000	0.038
30	0.088	32.931	105.3	3.468	14.655	17.341	1.826	-0.382	-0.359	-0.157	0.100	0.038
Recovery	0.088	47.794	107.1	5.119	15.544	25.168	2.696	-0.103	-0.053	-0.106	0.100	0.056

### +6 Gz

Pre-Run	0.107	56.539	96.2	5.439	12.606	29.773	2.864	0.000	0.000	0.000	0.000	0.000
10	0.064	24.409	113.4	2.768	17.145	12.854	1.458	-0.568	-0.491	0.360	-0.402	0.179
20	0.064	28.267	111.1	3.140	19.886	14.885	1.654	-0.500	-0.423	0.578	-0.402	0.155
30	0.070	23.260	109.1	2.538	16.823	12.249	1.336	-0.589	-0.533	0.335	-0.346	0.134
Recovery	0.080	60.905	107.1	6.523	18.922	32.072	3.435	0.077	0.199	0.501	-0.252	0.113

### +6.5 Gz

Pre-Run	0.100	44.966	108.7	4.888	13.235	23.679	2.574	0.000	0.000	0.000	0.000	0.000
10	0.064	27.718	111.1	3.079	20.514	14.596	1.622	-0.384	-0.370	0.550	-0.360	0.022
20	0.070	27.872	109.1	3.041	18.272	14.677	1.601	-0.380	-0.378	0.381	-0.300	0.004
30	0.088	32.246	111.1	3.583	15.496	16.980	1.887	-0.283	-0.267	0.171	-0.120	0.022
Recovery	0.088	51.991	103.4	5.376	17.546	27.378	2.831	0.156	0.100	0.311	-0.120	-0.049

### +7 Gz

Pre-Run	0.087	51.002	111.9	5.707	14.483	26.857	3.005	0.000	0.000	0.000	0.000	0.000
10	0.056	36.652	122.4	4.486	30.806	19.301	2.362	-0.281	-0.214	1.127	-0.356	0.094
20	0.080	34.570	115.4	3.989	20.587	18.204	2.101	-0.322	-0.301	0.421	-0.080	0.031
30	0.080	27.953	115.4	3.226	17.415	14.727	1.699	-0.452	-0.435	0.202	-0.080	0.031
Recovery	0.096	49.066	105.3	5.167	14.094	24.856	2.721	-0.038	-0.095	-0.027	0.103	-0.059

# NAWCADWAR-93086-60

## CARDIAC PARAMETERS CALCULATED DURING RELAXED ROR

SUBJECT: S1 SUIT: COMBAT EDGE DATE: 9/16/91

+4 Gz												
Time @	PWD	SV	HR	CO	HI	SI	CI	SI	CI	HI	PWD	HR
Plateau-s	(s)	(ml/beat)	(bpm)	(L/min)	(ohm)	(ml/bt/m2)	(L/bt/m2)	Normalized to 0				
Pre-Run	0.097	137.812	110.3	15.203	22.161	85.174	9.396	0.000	0.000	0.000	0.000	0.000
10	0.100	89.498	117.6	10.525	15.940	55.314	6.505	-0.351	-0.308	-0.281	0.031	0.066
20	0.094	78.159	122.4	9.567	15.639	48.306	5.913	-0.433	-0.371	-0.294	-0.031	0.109
30	0.086	80.348	125.0	10.043	18.237	49.659	6.207	-0.417	-0.339	-0.177	-0.113	0.133
Recovery	0.094	145.941	88.2	12.872	23.823	90.199	7.956	0.059	-0.153	0.075	-0.031	-0.201
+5 Gz												
Pre-Run	0.102	126.201	109.1	13.769	20.069	77.998	8.510	0.000	0.000	0.000	0.000	0.000
10	0.086	87.494	128.3	11.225	17.889	54.075	6.938	-0.307	-0.185	-0.109	-0.157	0.176
20	0.072	78.671	132.6	10.432	20.774	48.623	6.447	-0.377	-0.242	0.035	-0.294	0.215
30	0.070	85.277	134.8	11.495	23.077	52.705	7.105	-0.324	-0.165	0.150	-0.314	0.236
Recovery	0.092	127.127	118.2	15.026	22.529	78.570	9.287	0.007	0.091	0.123	-0.098	0.083
+6 Gz												
Pre-Run	0.095	129.383	113.6	14.698	19.433	79.965	9.084	0.000	0.000	0.000	0.000	0.000
10	0.104	92.114	137.9	12.703	16.190	56.931	7.851	-0.288	-0.136	-0.167	0.095	0.214
20	0.078	84.460	142.0	11.993	22.025	52.200	7.412	-0.347	-0.184	0.133	-0.179	0.250
30	0.067	76.168	143.7	10.945	22.643	47.075	6.765	-0.411	-0.255	0.165	-0.295	0.265
Recovery	0.080	109.274	131.1	14.326	26.603	67.536	8.854	-0.155	-0.025	0.369	-0.158	0.154
+6.5 Gz												
Pre-Run	0.102	140.045	122.0	17.085	20.613	86.554	10.560	0.000	0.000	0.000	0.000	0.000
10	0.108	97.092	136.4	13.243	15.393	60.007	8.185	-0.307	-0.225	-0.253	0.059	0.118
20	0.078	75.548	149.1	11.264	20.820	46.692	6.962	-0.461	-0.341	0.010	-0.235	0.222
30	0.066	85.147	148.8	12.670	25.317	52.625	7.831	-0.392	-0.258	0.228	-0.353	0.220
Recovery	0.094	118.905	119.4	14.197	21.004	73.489	8.775	-0.151	-0.169	0.019	-0.078	-0.021
+7 Gz PLL Run												
Pre-Run	0.088	132.696	113.6	15.074	21.999	82.012	9.317	0.000	0.000	0.000	0.000	0.000
10	0.106	80.879	147.2	11.905	17.215	49.987	7.358	-0.390	-0.210	-0.217	0.205	0.296
Recovery	0.088	137.495	118.2	16.252	22.145	84.978	10.044	0.036	0.078	0.007	0.000	0.040

# NAWCADWAR-93086-60

## CARDIAC PARAMETERS CALCULATED DURING RELAXED ROR

SUBJECT: S1 SUIT: COMBAT EDGE DATE: 9/18/91

### +4 Gz

Time @ Plateau-s	PLD (s)	SV (ml/beat)	HR (bpm)	CO (L/min)	HI (ohm)	SI (ml/bt/m2)	CI (L/bt/m2)	SI	CI	HI	PLD	HR
								Normalized to 0				
Pre-Run	0.073	153.271	110.3	16.906	36.112	94.729	10.449	0.000	0.000	0.000	0.000	0.000
10	0.088	139.827	115.4	16.136	26.490	86.420	9.973	-0.088	-0.046	0.734	0.205	0.046
20	0.088	109.702	118.4	12.989	23.866	67.801	8.028	-0.284	-0.232	0.661	0.205	0.073
30	0.072	93.664	120.0	11.240	28.655	57.889	6.947	-0.389	-0.335	0.794	-0.014	0.088
Recovery	0.080	124.768	115.4	14.398	27.505	77.113	8.899	-0.186	-0.148	0.762	0.096	0.046

### +5 Gz

Pre-Run	0.087	154.485	115.4	17.828	27.045	95.479	11.018	0.000	0.000	0.000	0.000	0.000
10	0.080	116.790	125.0	14.599	25.109	72.182	9.023	-0.244	-0.181	0.928	-0.080	0.083
20	0.080	95.146	136.4	12.978	21.705	58.805	8.021	-0.384	-0.272	0.803	-0.080	0.182
30	0.064	132.247	136.4	18.038	32.305	81.735	11.149	-0.144	0.012	1.194	-0.264	0.182
Recovery	0.070	184.913	93.8	17.345	43.044	114.285	10.720	0.197	-0.027	1.592	-0.195	-0.187

### +6 Gz

Pre-Run	0.080	143.271	115.4	16.533	30.202	88.548	10.218	0.000	0.000	0.000	0.000	0.000
10	0.090	105.142	128.6	13.521	20.116	64.983	8.357	-0.266	-0.182	-0.334	0.125	0.114
20	0.080	117.724	128.6	15.139	23.339	72.759	9.357	-0.178	-0.084	-0.227	0.000	0.114
30	0.080	98.318	125.0	12.290	28.186	60.765	7.596	-0.314	-0.257	-0.067	0.000	0.083
Recovery	0.070	192.977	117.6	22.694	36.726	119.269	14.026	0.347	0.373	0.216	-0.125	0.019

# NAWCADWAR-93086-60

## CARDIAC PARAMETERS CALCULATED DURING RELAXED ROR

SUBJECT: S2 SUIT: COMBAT EDGE DATE: 9/17/91

+4 Gz												
Time @	PWD	SV	HR	CO	HI	SI	CI	SI	CI	HI	PWD	HR
Plateau-s	(s)	(ml/beat)	(bpm)	(L/min)	(ohm)	(ml/bt/m2)	(L/bt/m2)	Normalized to 0				
Pre-Run	0.080	98.550	106.4	10.486	21.810	60.239	6.409	0.000	0.000	0.000	0.000	0.000
10	0.072	76.264	120.0	9.152	22.545	46.616	5.594	-0.226	-0.127	0.034	-0.100	0.128
20	0.072	73.103	120.0	8.772	23.510	44.684	5.362	-0.258	-0.163	0.078	-0.100	0.128
30	0.080	78.153	113.2	8.847	20.725	47.771	5.408	-0.207	-0.156	-0.050	0.000	0.064
Recovery	0.072	87.901	111.1	9.766	21.822	53.729	5.969	-0.108	-0.069	0.001	-0.100	0.044
+5 Gz												
Pre-Run	0.080	84.200	121.0	10.188	18.989	51.467	6.227	0.000	0.000	0.000	0.000	0.000
10	0.072	86.128	127.7	10.999	26.524	52.645	6.723	0.023	0.080	0.397	-0.100	0.055
20	0.080	83.325	133.3	11.107	23.980	50.932	6.789	-0.010	0.090	0.263	0.000	0.102
30	0.080	72.073	136.4	9.831	21.810	44.055	6.009	-0.144	-0.035	0.149	0.000	0.127
Recovery	0.088	102.525	101.7	10.427	21.208	62.668	6.373	0.218	0.023	0.117	0.100	-0.160
+5.5 Gz												
Pre-Run	0.067	116.134	108.7	12.624	27.337	70.986	7.716	0.000	0.000	0.000	0.000	0.000
10	0.072	89.257	133.3	11.898	24.113	54.558	7.273	-0.231	-0.057	-0.118	0.075	0.226
20	0.072	64.039	139.5	8.933	23.920	39.144	5.461	-0.449	-0.292	-0.125	0.075	0.283
30	0.072	69.069	139.5	9.635	24.957	42.218	5.889	-0.405	-0.237	-0.087	0.075	0.283
Recovery	0.088	123.206	114.3	14.082	23.576	75.309	8.608	0.061	0.116	-0.138	0.313	0.052
+6 Gz PLL Run												
Pre-Run	0.087	98.339	119.0	11.702	18.558	60.110	7.153	0.000	0.000	0.000	0.000	0.000
5	0.072	73.481	139.5	10.251	26.403	44.915	6.266	-0.253	-0.124	0.423	-0.172	0.172
Recovery	0.076	89.216	127.7	11.393	21.816	54.533	6.964	-0.093	-0.026	0.176	-0.126	0.073

# NAWCADWAR-93086-60

## CARDIAC PARAMETERS CALCULATED DURING RELAXED ROR

SUBJECT: S2 SUIT: COMBAT EDGE DATE: 9/19/91

### +4 Gz

Time @ Plateau-s	PWD (s)	SV (ml/beat)	HR (bpm)	CO (L/min)	HI (ohm)	SI (ml/bt/m2)	CI (L/bt/m2)	SI Normalized to 0	CI Normalized to 0	HI Normalized to 0	PWD	HR
Pre-Run	0.080	51.611	96.2	4.965	17.865	31.547	3.035	0.000	0.000	0.000	0.000	0.000
10	0.080	26.943	120.0	3.233	12.983	16.469	1.976	-0.478	-0.349	-0.273	0.000	0.247
20	0.080	39.266	113.2	4.445	17.060	24.001	2.717	-0.239	-0.105	-0.045	0.000	0.177
30	0.080	31.797	109.8	3.491	14.887	19.436	2.134	-0.384	-0.297	-0.167	0.000	0.141
Recovery	0.088	52.097	90.9	4.736	16.460	31.844	2.895	0.009	-0.046	-0.079	0.100	-0.055

### +4.5 Gz

Pre-Run	0.093	54.539	89.3	4.870	15.091	33.337	2.977	0.000	0.000	0.000	0.000	0.000
10	0.072	38.549	120.0	4.626	19.999	23.563	2.828	-0.293	-0.050	0.325	-0.226	0.344
20	0.090	32.422	107.1	3.472	13.066	19.818	2.122	-0.406	-0.287	-0.134	-0.032	0.199
30	0.090	25.830	115.4	2.981	11.612	15.789	1.822	-0.526	-0.388	-0.231	-0.032	0.292
Recovery	0.080	58.522	100.0	5.852	21.137	35.772	3.577	0.073	0.202	0.401	-0.140	0.120

### +5 Gz PLL Run

Pre-Run	0.087	47.660	105.6	5.033	15.539	29.132	3.076	0.000	0.000	0.000	0.000	0.000
5	0.096	39.269	125.0	4.909	13.814	24.003	3.000	-0.176	-0.025	-0.111	0.103	0.184
Recovery	0.072	59.967	109.1	6.542	24.887	36.655	3.999	0.258	0.300	0.602	-0.172	0.033

# NAWCADWAR-93086-60

## CARDIAC PARAMETERS CALCULATED DURING RELAXED ROR

SUBJECT: S3 SUIT: COMBAT EDGE DATE: 9/16/91

### +4 Gz

Time @ Plateau-s	PWD (s)	SV (ml/beat)	HR (bpm)	CO (L/min)	HI (ohm)	SI (ml/bt/m2)	CI (L/bt/m2)	SI Normalized to 0	CI Normalized to 0	HI Normalized to 0	PWD	HR
Pre-Run	0.100	68.808	102.7	7.067	16.900	36.234	3.721	0.000	0.000	0.000	0.000	0.000
10	0.098	57.849	110.4	6.386	15.035	30.463	3.363	-0.159	-0.096	-0.110	-0.020	0.075
20	0.106	63.444	115.4	7.321	13.620	33.409	3.855	-0.078	0.036	-0.194	0.060	0.124
30	0.098	55.836	114.7	6.404	16.768	29.403	3.373	-0.189	-0.094	-0.008	-0.020	0.117
Recovery	0.104	60.994	106.2	6.478	15.474	32.119	3.411	-0.114	-0.083	-0.084	0.040	0.034

### +4.5 Gz

Pre-Run	0.108	63.731	102.4	6.526	13.643	33.560	3.437	0.000	0.000	0.000	0.000	0.000
10	0.110	62.853	104.8	6.587	12.662	33.098	3.469	-0.014	0.009	-0.072	0.019	0.023
20	0.118	46.902	100.0	4.690	10.148	24.698	2.470	-0.264	-0.281	-0.256	0.093	-0.023
30	0.102	72.802	114.3	8.321	16.194	38.337	4.382	0.142	0.275	0.187	-0.056	0.116
Recovery	0.104	68.514	104.8	7.180	14.699	36.079	3.781	0.075	0.100	0.077	-0.037	0.023

### +5 Gz PLL Run

Pre-Run	0.120	57.959	103.8	6.016	11.430	30.521	3.168	0.000	0.000	0.000	0.000	0.000
10	0.093	86.989	118.4	10.299	20.729	45.808	5.424	0.501	0.712	0.814	-0.225	0.141
14	0.103	68.361	124.1	8.484	14.429	35.999	4.467	0.179	0.410	0.262	-0.142	0.196
Recovery	0.106	72.025	115.4	8.312	14.221	37.928	4.377	0.243	0.382	0.244	-0.117	0.112

## CARDIAC PARAMETERS CALCULATED DURING RELAXED ROR

SUBJECT: S3 SUIT: COMBAT EDGE DATE: 9/18/91

### +4 Gz

Time @ Plateau-s	PWD (s)	SV (ml/beat)	HR (bpm)	CO (L/min)	HI (ohm)	SI (ml/bt/m2)	CI (L/bt/m2)	SI Normalized to 0	CI Normalized to 0	HI Normalized to 0	PWD	HR
Pre-Run	0.093	56.442	111.9	6.316	18.093	29.722	3.326	0.000	0.000	0.000	0.000	0.000
10	0.088	59.250	122.4	7.252	21.591	31.201	3.819	0.050	0.148	0.193	-0.054	0.094
20	0.088	56.410	117.6	6.634	21.739	29.705	3.493	-0.001	0.050	0.202	-0.054	0.051
30	0.088	53.947	115.4	6.225	21.517	28.408	3.278	-0.044	-0.014	0.189	-0.054	0.031
Recovery	0.088	58.474	103.4	6.046	21.739	30.792	3.184	0.036	-0.043	0.202	-0.054	-0.076

### +5 Gz PLL Run

Pre-Run	0.100	54.559	115.4	6.296	16.891	28.730	3.315	0.000	0.000	0.000	0.000	0.000
10	0.080	57.857	130.4	7.545	21.549	30.467	3.973	0.060	0.198	0.276	-0.200	0.130
20	0.080	61.972	128.6	7.970	26.984	32.634	4.197	0.136	0.266	0.597	-0.200	0.114
Recovery	0.088	48.047	120.0	5.766	19.269	25.301	3.036	-0.119	-0.084	0.141	-0.120	0.040

# NAWCADWAR-93086-60

## CARDIAC PARAMETERS CALCULATED DURING RELAXED ROR

SUBJECT: S5 SUIT: COMBAT EDGE DATE: 9/19/91

+4 Gz												
Time @	PWD	SV	HR	CO	HI	SI	CI	SI	CI	HI	PWD	HR
Plateau-s	(s)	(ml/beat)	(bpm)	(L/min)	(ohm)	(ml/bt/m2)	(L/bt/m2)	Normalized to 0				
Pre-Run	0.056	53.956	104.2	5.622	23.810	28.715	2.992	0.000	0.000	0.000	0.000	0.000
10	0.056	51.165	101.7	5.203	27.151	27.230	2.769	-0.052	-0.074	0.140	0.000	-0.024
20	0.080	60.842	109.8	6.680	21.505	32.380	3.555	0.128	0.188	-0.097	0.429	0.054
30	0.056	57.390	112.5	6.456	30.722	30.543	3.436	0.064	0.148	0.290	0.000	0.080
Recovery	0.056	70.181	117.6	8.253	30.453	37.350	4.392	0.301	0.468	0.279	0.000	0.129
+5 Gz												
Pre-Run	0.087	66.014	92.6	6.113	17.723	35.132	3.253	0.000	0.000	0.000	0.000	0.000
10	0.064	45.751	102.3	4.680	22.648	24.349	2.491	-0.307	-0.234	0.278	-0.264	0.105
20	0.096	47.262	120.0	5.671	15.591	25.153	3.018	-0.284	-0.072	-0.120	0.103	0.296
30	0.070	48.848	120.0	5.862	23.257	25.997	3.120	-0.260	-0.041	0.312	-0.195	0.296
Recovery	0.072	51.841	107.1	5.552	21.117	27.590	2.955	-0.215	-0.092	0.191	-0.172	0.157
+6 Gz												
Pre-Run	0.067	51.757	111.9	5.792	20.639	27.545	3.082	0.000	0.000	0.000	0.000	0.000
10	0.080	47.288	115.4	5.457	20.591	25.166	2.904	-0.086	-0.058	-0.002	0.194	0.031
20	0.080	47.561	120.0	5.707	21.290	25.312	3.037	-0.081	-0.015	0.032	0.194	0.072
30	0.053	54.717	120.0	6.566	38.953	29.120	3.494	0.057	0.134	0.887	-0.209	0.072
Recovery	0.096	54.805	117.6	6.445	16.958	29.167	3.430	0.059	0.113	-0.178	0.433	0.051
+7 Gz												
Pre-Run	0.067	75.231	101.4	7.628	22.244	40.038	4.060	0.000	0.000	0.000	0.000	0.000
10	0.070	39.629	121.6	4.819	21.137	21.091	2.565	-0.473	-0.368	-0.050	0.045	0.199
20	0.040	42.190	125.0	5.274	37.957	22.454	2.807	-0.439	-0.309	0.706	-0.403	0.233
30	0.080	32.931	125.0	4.116	15.349	17.526	2.191	-0.562	-0.460	-0.310	0.194	0.233
Recovery	0.048	67.182	117.6	7.901	39.382	35.754	4.205	-0.107	0.036	0.770	-0.284	0.160

# NAWCADWAR-93086-60

## CARDIAC PARAMETERS CALCULATED DURING RELAXED ROR

SUBJECT: S6 SUIT: COMBAT EDGE DATE: 9/17/91

### +4 Gz

Time @	PWD	SV	HR	CO	HI	SI	CI	SI	CI	HI	PWD	HR
Plateau-s	(s)	(ml/beat)	(bpm)	(L/min)	(ohm)	(ml/bt/m2)	(L/bt/m2)	Normalized to 0				

Pre-Run	0.100	40.907	117.2	4.794	13.769	21.541	2.525	0.000	0.000	0.000	0.000	0.000
10	0.056	41.549	120.0	4.986	26.027	21.879	2.626	0.016	0.040	0.890	-0.440	0.024
20	0.064	42.210	117.6	4.964	23.250	22.227	2.614	0.032	0.035	0.689	-0.360	0.003
30	0.060	40.129	121.6	4.880	24.183	21.132	2.570	-0.019	0.018	0.756	-0.400	0.038
Recovery	0.096	47.767	119.0	5.684	15.160	25.154	2.993	0.168	0.186	0.101	-0.040	0.015

### +4.5 Gz

Pre-Run	0.107	51.102	117.2	5.989	13.214	26.910	3.154	0.000	0.000	0.000	0.000	0.000
10	0.072	39.079	122.4	4.783	18.367	20.579	2.519	-0.235	-0.201	0.390	-0.327	0.044
20	0.080	38.793	122.4	4.748	16.503	20.428	2.500	-0.241	-0.207	0.249	-0.252	0.044
30	0.120	36.907	125.0	4.613	10.276	19.435	2.429	-0.278	-0.230	-0.222	0.121	0.067
Recovery	0.088	54.310	111.1	6.034	17.256	28.599	3.177	0.063	0.007	0.306	-0.178	-0.052

### +5 Gz PLL Run

Pre-Run	0.100	54.141	119.0	6.443	14.118	28.510	3.393	0.000	0.000	0.000	0.000	0.000
9	0.056	24.887	130.4	3.245	25.366	13.105	1.709	-0.540	-0.496	0.797	-0.440	0.096
Recovery	0.070	65.208	120.0	7.825	21.164	34.338	4.121	0.204	0.215	0.499	-0.300	0.008

## CARDIAC PARAMETERS CALCULATED DURING RELAXED ROR

SUBJECT: S6 SUIT: COMBAT EDGE DATE: 9/19/91

### +4 Gz

Time @	PWD	SV	HR	CO	HI	SI	CI	SI	CI	HI	PWD	HR
Plateau-s	(s)	(ml/beat)	(bpm)	(L/min)	(ohm)	(ml/bt/m2)	(L/bt/m2)	Normalized to 0				

Pre-Run	0.080	73.367	96.2	7.058	17.925	38.635	3.717	0.000	0.000	0.000	0.000	0.000
10	0.080	56.130	95.2	5.344	18.999	29.558	2.814	-0.235	-0.243	0.060	0.000	-0.010
20	0.080	52.163	100.0	5.216	18.056	27.469	2.747	-0.289	-0.261	0.007	0.000	0.040
30	0.070	57.682	96.8	5.584	21.863	30.375	2.940	-0.214	-0.209	0.220	-0.125	0.006
Recovery	0.048	74.684	96.8	7.229	31.272	39.328	3.807	0.018	0.024	0.745	-0.400	0.006

### +5 Gz

Pre-Run	0.080	73.189	100.0	7.319	20.047	38.541	3.854	0.000	0.000	0.000	0.000	0.000
10	0.056	38.304	107.1	4.102	20.927	20.171	2.160	-0.477	-0.439	0.044	-0.300	0.071
20	0.064	43.097	105.3	4.538	19.621	22.695	2.390	-0.411	-0.380	-0.021	-0.200	0.053
30	0.064	32.705	107.1	3.503	16.247	17.222	1.844	-0.553	-0.521	-0.190	-0.200	0.071
Recovery	0.048	71.782	93.8	6.733	31.883	37.800	3.546	-0.019	-0.080	0.590	-0.400	-0.062

### +6 Gz

Pre-Run	0.067	74.604	97.4	7.266	21.621	39.286	3.826	0.000	0.000	0.000	0.000	0.000
10	0.080	34.497	112.5	3.881	12.893	18.166	2.044	-0.538	-0.466	-0.404	0.194	0.155
20	0.072	32.918	111.1	3.657	15.956	17.334	1.926	-0.559	-0.497	-0.262	0.075	0.141
30	0.060	30.299	107.1	3.245	16.841	15.955	1.709	-0.594	-0.553	-0.221	-0.104	0.100
Recovery	0.080	95.757	101.7	9.738	21.803	50.425	5.128	0.284	0.340	0.008	0.194	0.044

# NAWCADWAR-93086-60

## CARDIAC PARAMETERS CALCULATED DURING RELAXED GOR

SUBJECT: S1 SUIT: TLSS DATE: 9/17/91

+Gz / Epoch	PWD (s)	SV (ml/beat)	HR (bpm)	CO (L/min)	HI (ohm)	SI (ml/bt/m2)	CI (L/bt/m2)	SI Normalized to 0	CI Normalized to 0	HI Normalized to 0	PWD	HR
Pre-Run	0.047	147.590	110.3	16.279	64.146	91.218	10.061	0.000	0.000	0.000	0.000	0.000
2	0.040	129.424	128.6	16.644	90.234	79.990	10.287	-0.123	0.022	0.407	-0.149	0.166
3		122.732	125.0	15.341		75.854	9.482	-0.168	-0.058			0.133
4		114.660	128.6	14.745		70.865	9.113	-0.223	-0.094			0.166
5		72.538	136.4	9.894		44.832	6.115	-0.509	-0.392			0.237
6		93.211	136.4	12.714		57.609	7.858	-0.368	-0.219			0.237
7		67.246	157.9	10.618		41.561	6.563	-0.544	-0.348			0.432
8		73.322	150.0	10.998		45.317	6.797	-0.503	-0.324			0.360
9		88.335	157.9	13.948		54.595	8.621	-0.401	-0.143			0.432
Recovery		112.214	145.2	16.293		69.353	10.070	-0.240	0.001			0.316

SUBJECT: S2 SUIT: TLSS DATE: 9/16/91

+Gz / Epoch	PWD (s)	SV (ml/beat)	HR (bpm)	CO (L/min)	HI (ohm)	SI (ml/bt/m2)	CI (L/bt/m2)	SI Normalized to 0	CI Normalized to 0	HI Normalized to 0	PWD	HR
Pre-Run	0.083	55.939	125.0	6.992	20.806	34.193	4.274	0.000	0.000	0.000	0.000	0.000
2	0.080	70.867	126.8	8.986	29.515	43.317	5.493	0.267	0.285	0.419	-0.036	0.014
3	0.062	43.234	102.3	4.423	27.213	26.427	2.703	-0.227	-0.367	0.308	-0.253	-0.182
4	0.050	51.564	125.9	6.492	38.414	31.518	3.968	-0.078	-0.072	0.846	-0.398	0.007
5	0.070	35.893	134.3	4.820	18.250	21.940	2.946	-0.358	-0.311	-0.123	-0.157	0.074
6	0.055	43.367	134.3	5.824	31.237	26.508	3.560	-0.225	-0.167	0.501	-0.337	0.074
7	0.053	38.007	139.5	5.302	30.588	23.232	3.241	-0.321	-0.242	0.470	-0.361	0.116
8	0.050	47.159	150.0	7.074	41.145	28.826	4.324	-0.157	0.012	0.978	-0.398	0.200
9	0.053	44.238	153.8	6.804	41.892	27.041	4.159	-0.209	-0.027	1.013	-0.361	0.230
Recovery	0.032	48.707	136.4	6.644	60.160	29.772	4.061	-0.129	-0.050	1.892	-0.614	0.091

SUBJECT: S2 SUIT: TLSS DATE: 9/18/91

+Gz / Epoch	PWD (s)	SV (ml/beat)	HR (bpm)	CO (L/min)	HI (ohm)	SI (ml/bt/m2)	CI (L/bt/m2)	SI Normalized to 0	CI Normalized to 0	HI Normalized to 0	PWD	HR
Pre-Run	0.080	69.841	102.7	7.173	25.708	42.690	4.384	0.000	0.000	0.000	0.000	0.000
2	0.080	58.421	118.3	6.911	24.864	35.710	4.224	-0.164	-0.036	-0.033	0.000	0.152
3	0.080	50.903	128.5	6.541	21.814	31.114	3.998	-0.271	-0.088	-0.151	0.000	0.251
4	0.050	45.758	100.0	4.576	35.773	27.969	2.797	-0.345	-0.362	0.392	-0.375	-0.026
5	0.060	37.933	121.7	4.616	26.253	23.186	2.822	-0.457	-0.356	0.021	-0.250	0.185
6	0.060	35.778	128.5	4.597	24.328	21.869	2.810	-0.488	-0.359	-0.054	-0.250	0.251
7	0.060	39.447	128.5	5.069	29.049	24.112	3.098	-0.435	-0.293	0.130	-0.250	0.251
8	0.060	39.370	121.7	4.791	29.267	24.065	2.929	-0.436	-0.332	0.138	-0.250	0.185
9	0.070	35.181	130.4	4.588	22.720	21.504	2.804	-0.496	-0.360	-0.116	-0.125	0.270
Recovery	0.060	55.138	132.5	7.306	34.858	33.703	4.466	-0.211	0.019	0.356	-0.250	0.290

# NAWCADWAR-93086-60

## CARDIAC PARAMETERS CALCULATED DURING RELAXED GOR

SUBJECT: S3 SUIT: TLSS DATE: 9/17/91

+Gz / Epoch	PWD (s)	SV (ml/beat)	HR (bpm)	CO (L/min)	HI (ohm)	SI (ml/bt/m2)	CI (L/bt/m2)	SI Normalized to 0	CI Normalized to 0	HI Normalized to 0	PWD	HR
Pre-Run	0.087	97.519	98.7	9.625	25.330	51.353	5.069	0.000	0.000	0.000	0.000	0.000
2	0.080	120.175	107.1	12.871	29.083	63.283	6.778	0.232	0.337	0.148	-0.080	0.085
3	0.072	104.710	113.2	11.853	29.022	55.139	6.242	0.074	0.231	0.146	-0.172	0.147
4	0.080	96.600	105.3	10.172	25.680	50.869	5.357	-0.009	0.057	0.014	-0.080	0.067
5	0.090	91.614	112.5	10.307	21.852	48.243	5.427	-0.061	0.071	-0.137	0.034	0.140
Recovery	0.072	99.783	133.3	13.301	33.167	52.545	7.004	0.023	0.382	0.309	-0.172	0.351

SUBJECT: S4 SUIT: TLSS DATE: 9/16/91

+Gz / Epoch	PWD (s)	SV (ml/beat)	HR (bpm)	CO (L/min)	HI (ohm)	SI (ml/bt/m2)	CI (L/bt/m2)	SI Normalized to 0	CI Normalized to 0	HI Normalized to 0	PWD	HR
Pre-Run	0.062	38.322	125.0	4.790	25.752	20.416	2.552	0.000	0.000	0.000	0.000	0.000
2	0.063	32.727	151.3	4.952	17.420	17.436	2.638	-0.146	0.034	-0.324	0.016	0.210
3	0.060	35.141	148.8	5.229	19.315	18.722	2.786	-0.083	0.092	-0.250	-0.032	0.190
4	0.060	33.815	148.8	5.032	18.785	18.015	2.681	-0.118	0.050	-0.271	-0.032	0.190
5	0.065	30.797	156.5	4.820	18.611	16.407	2.568	-0.196	0.006	-0.277	0.048	0.252
6	0.070	31.016	160.7	4.984	15.738	16.524	2.655	-0.191	0.041	-0.389	0.129	0.286
7	0.070	30.737	174.8	5.373	16.132	16.376	2.862	-0.198	0.122	-0.374	0.129	0.398
8	0.073	28.918	181.8	5.257	14.860	15.406	2.801	-0.245	0.097	-0.423	0.177	0.454
9	0.085	26.670	185.6	4.950	12.438	14.209	2.637	-0.304	0.033	-0.517	0.371	0.485
10	0.065	27.708	187.5	5.195	17.340	14.762	2.768	-0.277	0.085	-0.327	0.048	0.500
Recovery	0.068	25.387	168.2	4.270	15.921	13.525	2.275	-0.338	-0.109	-0.382	0.097	0.346

SUBJECT: S4 SUIT: TLSS DATE: 9/18/91

+Gz / Epoch	PWD (s)	SV (ml/beat)	HR (bpm)	CO (L/min)	HI (ohm)	SI (ml/bt/m2)	CI (L/bt/m2)	SI Normalized to 0	CI Normalized to 0	HI Normalized to 0	PWD	HR
Pre-Run	0.077	106.969	89.8	9.606	27.303	56.989	5.118	0.000	0.000	0.000	0.000	0.000
2	0.070	90.648	107.1	9.708	28.693	48.294	5.172	-0.153	0.011	0.051	-0.091	0.193
3	0.070	105.548	103.4	10.914	33.811	56.232	5.814	-0.013	0.136	0.238	-0.091	0.151
4	0.080	101.251	100.0	10.125	25.160	53.943	5.394	-0.053	0.054	-0.078	0.039	0.114
5	0.080	77.351	125.0	9.669	24.067	41.210	5.151	-0.277	0.007	-0.119	0.039	0.392
6	0.080	66.696	128.6	8.577	20.389	35.533	4.570	-0.376	-0.107	-0.253	0.039	0.432
6.8	0.040	107.180	136.4	14.619	69.829	57.102	7.789	0.002	0.522	1.558	-0.481	0.519
Recovery	0.060	105.734	120.0	12.688	39.446	56.331	6.760	-0.012	0.321	0.445	-0.221	0.336

# NAWCADWAR-93086-60

## CARDIAC PARAMETERS CALCULATED DURING RELAXED GOR

SUBJECT: S4 SUIT: TLSS DATE: 9/19/91

+Gz / Epoch	PWD (s)	SV (ml/beat)	HR (bpm)	CO (L/min)	HI (ohm)	SI (ml/bt/m2)	CI (L/bt/m2)	SI Normalized to 0	CI Normalized to 0	HI Normalized to 0	PWD	HR
Pre-Run	0.087	86.266	102.7	8.859	24.255	45.959	4.720	0.000	0.000	0.000	0.000	0.000
2	0.090	97.831	112.5	11.006	25.424	52.121	5.864	0.134	0.242	0.048	0.034	0.095
3	0.080	106.095	125.0	13.262	30.191	56.524	7.065	0.230	0.497	0.245	-0.080	0.217
4	0.065	66.339	115.4	7.656	26.532	35.343	4.079	-0.231	-0.136	0.094	-0.253	0.124
5	0.070	73.541	132.4	9.737	23.850	39.180	5.187	-0.148	0.099	-0.017	-0.195	0.289
6	0.070	49.963	140.6	7.025	21.610	26.619	3.743	-0.421	-0.207	-0.109	-0.195	0.369
7	0.060	52.070	145.2	7.561	25.212	27.741	4.028	-0.396	-0.147	0.039	-0.310	0.414
8	0.060	35.307	155.2	5.480	19.527	18.810	2.919	-0.591	-0.381	-0.195	-0.310	0.511
8.4	0.053	38.045	142.9	5.437	24.145	20.269	2.896	-0.559	-0.386	-0.005	-0.391	0.391
Recovery	0.072	61.644	125.0	7.705	25.806	32.842	4.105	-0.285	-0.130	0.064	-0.172	0.217

SUBJECT: S6 SUIT: TLSS DATE: 9/18/91

+Gz / Epoch	PWD (s)	SV (ml/beat)	HR (bpm)	CO (L/min)	HI (ohm)	SI (ml/bt/m2)	CI (L/bt/m2)	SI Normalized to 0	CI Normalized to 0	HI Normalized to 0	PWD	HR
Pre-Run	0.060	54.869	107.1	5.876	28.717	28.894	3.095	0.000	0.000	0.000	0.000	0.000
2	0.060	64.210	109.8	7.050	33.087	33.812	3.713	0.170	0.200	0.152	0.000	0.025
3	0.060	57.343	112.5	6.451	30.832	30.197	3.397	0.045	0.098	0.074	0.000	0.050
4	0.040	41.217	95.7	3.944	54.440	21.704	2.077	-0.249	-0.329	0.896	-0.333	-0.106
5	0.060	34.181	107.1	3.661	24.841	18.000	1.928	-0.377	-0.377	-0.135	0.000	0.000
6	0.070	31.207	109.8	3.426	20.145	16.433	1.804	-0.431	-0.417	-0.299	0.167	0.025
7	0.090	35.098	118.4	4.156	18.934	18.482	2.188	-0.360	-0.293	-0.341	0.500	0.106
7.2	0.080	28.219	120.0	3.386	19.001	14.860	1.783	-0.486	-0.424	-0.338	0.333	0.120
Recovery	0.056	66.039	100.0	6.604	34.733	34.776	3.478	0.204	0.124	0.209	-0.067	-0.066

## CARDIAC PARAMETERS CALCULATED DURING RELAXED GOR

SUBJECT: S1 SUIT: COMBAT EDGE DATE: 9/16/91

+Gz / Epoch	PMD (s)	SV (ml/beat)	HR (bpm)	CO (L/min)	HI (ohm)	SI (ml/bt/m2)	CI (L/bt/m2)	SI	CI	HI	PMD	HR
								Normalized to 0				
Pre-Run	0.082	143.763	120.0	17.252	32.208	88.852	10.662	0.000	0.000	0.000	0.000	0.000
2	0.063	155.156	126.8	19.674	53.656	95.894	12.159	0.079	0.140	0.666	-0.232	0.057
3	0.065	204.041	141.7	28.913	57.296	126.107	17.869	0.419	0.676	0.782	-0.207	0.181
4	0.055	162.978	142.9	23.290	64.336	100.728	14.394	0.134	0.350	0.998	-0.329	0.191
5	0.060	141.141	147.5	20.818	57.977	87.232	12.867	-0.018	0.207	0.800	-0.268	0.229
6	0.058	75.799	156.5	11.863	45.609	46.847	7.332	-0.473	-0.312	0.416	-0.293	0.304
7	0.060	69.933	163.6	11.441	43.732	43.222	7.071	-0.514	-0.337	0.358	-0.268	0.363
8	0.068	100.568	176.5	17.750	40.787	62.156	10.970	-0.300	0.029	0.266	-0.171	0.471
Recovery	0.058	199.044	98.4	19.586	81.049	123.019	12.105	0.385	0.135	1.516	-0.293	-0.180

SUBJECT: S1 SUIT: COMBAT EDGE DATE: 9/18/91

+Gz / Epoch	PMD (s)	SV (ml/beat)	HR (bpm)	CO (L/min)	HI (ohm)	SI (ml/bt/m2)	CI (L/bt/m2)	SI	CI	HI	PMD	HR
								Normalized to 0				
Pre-Run	0.053	145.865	121.0	17.650	59.193	90.152	10.908	0.000	0.000	0.000	0.000	0.000
2	0.050	173.204	125.0	21.651	86.275	107.048	13.381	0.187	0.227	0.457	-0.057	0.033
3	0.050	160.545	132.4	21.256	66.231	99.224	13.137	0.101	0.204	0.119	-0.057	0.094
4	0.050	125.230	140.6	17.607	57.081	77.398	10.882	-0.141	-0.002	-0.036	-0.057	0.162
5	0.050	115.740	140.6	16.273	54.902	71.533	10.057	-0.207	-0.078	-0.073	-0.057	0.162
6	0.053	96.191	140.6	13.525	47.273	59.451	8.359	-0.341	-0.234	-0.201	0.000	0.162
7	0.070	93.567	145.2	13.586	31.435	57.829	8.397	-0.359	-0.230	-0.469	0.321	0.200
Recovery	0.040	162.750	112.2	18.261	78.431	100.587	11.286	0.116	0.035	0.325	-0.245	-0.073

SUBJECT: S2 SUIT: COMBAT EDGE DATE: 9/17/91

+Gz / Epoch	PMD (s)	SV (ml/beat)	HR (bpm)	CO (L/min)	HI (ohm)	SI (ml/bt/m2)	CI (L/bt/m2)	SI	CI	HI	PMD	HR
								Normalized to 0				
Pre-Run	0.096	89.100	90.9	8.099	17.090	54.462	4.951	0.000	0.000	0.000	0.000	0.000
2	0.088	81.074	105.3	8.537	21.800	49.556	5.218	-0.090	0.054	0.276	-0.083	0.158
3	0.072	81.433	127.7	10.399	26.524	49.776	6.356	-0.086	0.284	0.552	-0.250	0.405
4	0.080	64.978	125.0	8.122	21.159	39.717	4.965	-0.271	0.003	0.238	-0.167	0.375
4.8	0.070	66.383	130.4	8.656	23.437	40.576	5.291	-0.255	0.069	0.371	-0.271	0.435
Recovery	0.065	43.991	155.2	6.827	29.781	26.889	4.173	-0.506	-0.157	0.743	-0.323	0.707

# NAWCADWAR-93086-60

## CARDIAC PARAMETERS CALCULATED DURING RELAXED GOR

SUBJECT: S2 SUIT: COMBAT EDGE DATE: 9/19/91

+Gz / Epoch	PWD (s)	SV (ml/beat)	HR (bpm)	CO (L/min)	HI (ohm)	SI (ml/bt/m2)	CI (L/bt/m2)	SI	CI	HI	PWD	HR
								Normalized to 0				
Pre-Run	0.080	62.649	84.3	5.281	19.930	38.294	3.228	0.000	0.000	0.000	0.000	0.000
2	0.088	63.992	107.1	6.854	18.752	39.115	4.189	0.021	0.298	-0.059	0.100	0.270
3	0.088	62.251	125.0	7.781	17.850	38.051	4.756	-0.006	0.473	-0.104	0.100	0.483
4	0.088	43.725	115.4	5.046	14.973	26.727	3.084	-0.302	-0.045	-0.249	0.100	0.369
5	0.080	41.169	117.6	4.841	16.041	25.164	2.959	-0.343	-0.083	-0.195	0.000	0.395
6	0.080	38.461	125.0	4.808	16.389	23.509	2.939	-0.386	-0.090	-0.178	0.000	0.483
7	0.080	45.599	125.0	5.700	20.198	27.873	3.484	-0.272	0.079	0.013	0.000	0.483
7.5	0.080	21.869	150.0	3.280	12.527	13.368	2.005	-0.651	-0.379	-0.371	0.000	0.779
Recovery	0.080	64.079	98.4	6.305	24.303	39.168	3.854	0.023	0.194	0.219	0.000	0.167

SUBJECT: S3 SUIT: COMBAT EDGE DATE: 9/18/91

+Gz / Epoch	PWD (s)	SV (ml/beat)	HR (bpm)	CO (L/min)	HI (ohm)	SI (ml/bt/m2)	CI (L/bt/m2)	SI	CI	HI	PWD	HR
								Normalized to 0				
Pre-Run	0.100	58.178	110.3	6.417	18.196	30.636	3.379	0.000	0.000	0.000	0.000	0.000
2	0.080	65.861	117.6	7.745	25.978	34.682	4.079	0.132	0.207	0.428	-0.200	0.066
3	0.088	72.522	122.4	8.877	26.433	38.190	4.674	0.247	0.383	0.453	-0.120	0.110
4	0.080	61.586	115.4	7.107	25.462	32.431	3.742	0.059	0.108	0.399	-0.200	0.046
4.9	0.080	54.844	125.0	6.856	22.989	28.880	3.610	-0.057	0.068	0.263	-0.200	0.133
Recovery	0.096	67.335	109.1	7.346	20.924	35.458	3.868	0.157	0.145	0.150	-0.040	-0.011

SUBJECT: S6 SUIT: COMBAT EDGE DATE: 9/17/91

+Gz / Epoch	PWD (s)	SV (ml/beat)	HR (bpm)	CO (L/min)	HI (ohm)	SI (ml/bt/m2)	CI (L/bt/m2)	SI	CI	HI	PWD	HR
								Normalized to 0				
Pre-Run	0.073	51.874	102.7	5.327	20.951	27.317	2.805	0.000	0.000	0.000	0.000	0.000
2	0.050	36.215	118.4	4.288	26.362	19.071	2.258	-0.302	-0.195	0.258	-0.315	0.153
3	0.060	45.906	125.0	5.738	29.775	24.174	3.022	-0.115	0.077	0.421	-0.178	0.217
4	0.040	49.913	125.0	6.239	51.797	26.284	3.285	-0.038	0.171	1.472	-0.452	0.217
5	0.040	43.079	128.6	5.540	44.336	22.685	2.917	-0.170	0.040	1.116	-0.452	0.252
Recovery	0.040	48.493	150.0	7.274	48.366	25.536	3.830	-0.065	0.365	1.309	-0.452	0.461